JOURNAL *of* FORESTRY

November
1929
Vol. XXVII Number 7

Published by the
SOCIETY of AMERICAN FORESTERS

Single Copy Sixty Five Cents Four Dollars per Year

JOURNAL of FORESTRY

A professional journal published by the Society of American Foresters and devoted to all branches of forestry

Entered as second-class matter at the post-office at Washington, D. C.

Acceptance for mailing at special rate of postage provided for in the Act of February 28, 1925, embodied in paragraph 4, Section 412, P. L. and R. authorized November 10, 1927.

Office of Publication, Room 517, Lenox Bldg., Washington, D. C.

The JOURNAL appears eight times a year monthly—with the exception of June, July, August, and September.

The pages of the JOURNAL are open to members and non-members of the Society.

Manuscripts intended for publication should be sent to Samuel T. Dana, School of Forestry and Conservation, University of Michigan, Ann Arbor, Michigan, or to any member of the Editorial Board.

Missing numbers will be replaced without charge, provided claim is made within thirty days after date of the following issue.

Subscriptions, advertising, and other business matters should be sent to the JOURNAL OF FORESTRY, Room 517, Lenox Bldg., 1523 L St. N. W., Washington, D. C.

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VOL. XXVII NOVEMBER, 1929 No. 7

The Society is not responsible, as a body, for the facts and opinions advanced in the papers published by it.

EDITORIAL

THE LUMBER INDUSTRY SPEAKS

TWO years ago the JOURNAL OF FORESTRY, in commenting editorially on the trade extension program of the lumber industry, called attention to faith in the future of our forests as an essential condition for the success of the movement. "Unless the industry can convince the public that the perpetuation of the forest is as much its concern as the sale of the product, the campaign will not make much headway. . . . . No one will be enthusiastic to use wood, if it is bought at the sacrifice of the forest and regardless of the future use of land."

Today the JOURNAL congratulates the industry on the interest in forest production evinced in the statement of forestry policy recently adopted by the Directors of the National Lumber Manufacturers Association. Under the heading "Need for a Definite, Constructive, and Aggressive Program of Forestry," the Directors state that, "the lumber industry has the greatest stake of all in the forest future of the country since it owns practically half the forest acreage and is intimately concerned with the other half, whether public or private, as a means of perpetuating the sources of its livelihood. Therefore the National Lumber Manufacturers Association logically should take the initiative in formulation of policies affecting the care and management alike of public forests and of private timberlands."

Compare this recognition of the industry's self-interest in the future of our forests with the statement a decade ago by Harry T. Kendall, General Sales Agent of the Kirby Lumber Company, that ". . . . as a lumberman, my interest in forestry is nil. . . . . When the lumberman of today saws the trees he owns and scraps his plant, his capital will enable him to become the banker, the ranchman, or the manufacturer of some other commodity. . . . ." Truly the world moves.

The most interesting and significant part of the Directors' statement of policy is that dealing with "commercial forestry, the business of growing crops of timber on private land." In brief, lumber manufacturers and timberland owners are urged to make a thorough economic study and careful analysis of the forest-growing possibilities of their holdings, and to "stand ready" to extend the practice of commercial forestry as far and as fast as dependably ascertained economic facts and prospects will warrant. Selective logging and sustained yield are presented as deserving special study. The National

Lumber Manufacturers Association offers its assistance in facilitating such studies. Recognition of the soundness of the position taken by the JOURNAL two years ago is contained in the statement that "timber and lumber products that are known to have come from well-managed 'sustained yield' forests will sell more readily than those produced through logging operations which are commonly accepted as resulting in substantial forest destruction."

There will doubtless be critics who will regard the Directors' recommendations concerning commercial forestry as vague and unconvincing, particularly in comparison with their more lengthy, detailed, and positive recommendations concerning public policy; who will be skeptical as the "gratifying progress" made by lumber companies in the last ten years in the application of forest-growing principles; who will wonder as to the exact number and location of the "many" who have found it profitable to adopt improved methods of forest practice; and who will even query whether the entire statement is not primarily propaganda to sell more wood.

The JOURNAL OF FORESTRY prefers to accept the Association's pronouncement at its face value as a constructive effort on the part of a great industry to assist in the solution of our forest problem. Its outstanding significance lies in its recognition that private owners have both a responsibility and an opportunity in the management of their forest lands. Once this fact is fully accepted, greater emphasis on its obvious implications and the working out of detailed programs for stimulating or enforcing private land management will follow in due course. Incidentally, the Society of American Foresters has an exceptional opportunity, through its Committee on Forest Policy and subsequent action by the entire membership, to hasten progress in this direction and to demonstrate its capacity for leadership by the formulation and support of a concrete and workable program for promoting private as well as public forestry.

The lumber industry has spoken and spoken well. Actions, however, still speak louder than words. May we suggest that as one means of demonstrating the genuineness of its interest and of promoting action the Association arrange for a thoroughgoing survey of the probable costs and returns from private forestry similar to the recently undertaken survey of prospective lumber requirements? Such a study would not only recognize definitely that the provision of adequate supplies of raw material for the industry is as important as their utilization, and at the same time give practical effect to the Association's general offer of assistance; its results would also receive more serious consideration and carry greater weight with most timberland owners than the results of any similar study by the federal government or other public agency.

The insistence of the lumber industry that improvement in the present management of private timberlands must come voluntarily from within rather than by compulsion from without makes it doubly important that the National Lumber Manufacturers Association, as the recognized leader of the industry, should leave no stone unturned to translate its fine words into fine deeds. Final judgment as to the effectiveness of its recent declaration of policy will depend on the extent to which it succeeds in bringing about the practice of forestry in the woods.

THE LESS YOU CUT, THE MORE YOU CUT

By W. W. ASHE
Washington, D. C.

ON THE AVERAGE sites[1] a stand of loblolly pine must be about 35 years old before it can fully utilize the capacity of the soil for producing sawtimber. Trees of sawtimber size—11 inches and over in diameter—are not produced until the stand is at least 25 years old. When the stand is from 25 to 30 years old the rate of increase of the sawtimber is approximately 400 board feet a year; at 35 years it is 2000 board feet a year; and at 40 years it is about 1400 board feet a year. The year when the capacity for increment in this form is at its maximum probably lies between the ages of 35 and 40 years.

In order that the capacity of the soil for producing sawtimber may be utilized to the fullest degree, it is necessary that the stand be maintained throughout its entire rotation in a condition approximating as nearly as possible the condition characteristic of this age.

This statement, which I casually introduced into a paper read before the Pennsylvania Forestry Association in June, 1925, and later repeated, has evoked a number of personal inquiries. It may be worthwhile to enlarge on the principle, in view of its relation to the selection system and to partial or to progressive fellings (Swiss shelterwood system) or to the practice of carrying forward many slender intermediate trees of rapid growth to produce larger diameters (high forest with standards); and because of its favorable bearing upon the desirability of these classes of cuttings in the present stage of forestry development in this country.

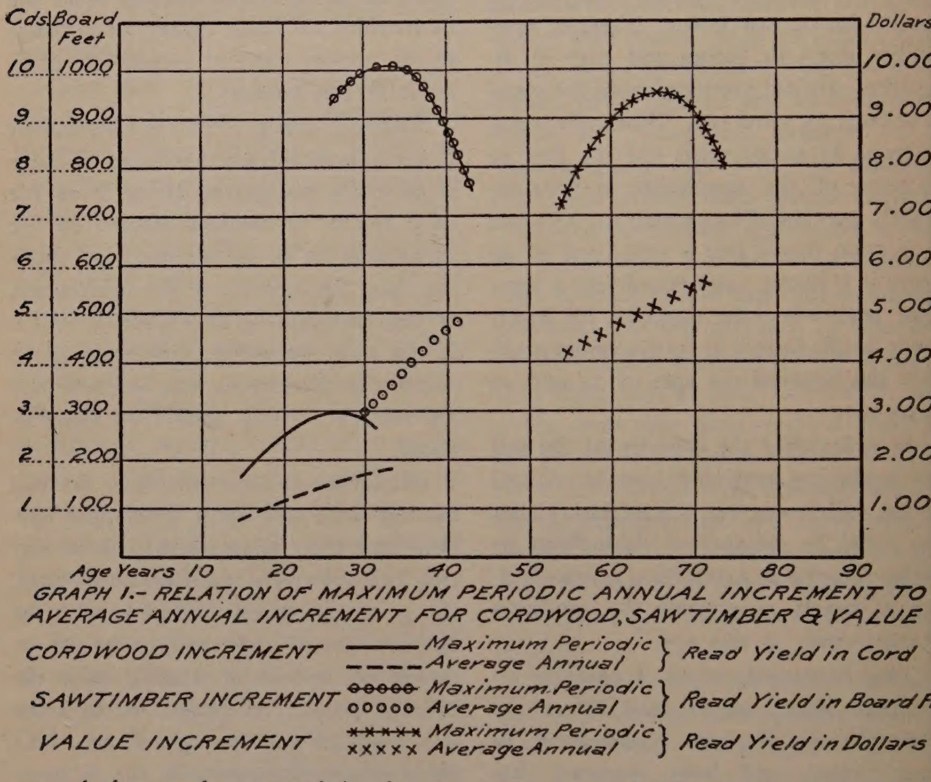
Although this principle is well known it seems doubtful whether its significance is generally recognized either in so far as it relates to absolute returns on the investment or in its psychological bearing upon the attitude of the landowners to the management of woodland, which is the most important consideration in forestry at the present time and to which all related activity should be subordinated.

In contrast to clean cutting or to clean cutting with seed trees (even-aged systems and their adaptations), or to cutting to a relatively small diameter limit, this principle represents dealing with the current annual increment when at its maximum instead of dealing with the average annual increment through the entire age of an even-aged stand. It is applicable to increment in the form of cubic feet or cordwood. It is applicable to the production of sawtimber yield without considering its value and is likewise applicable to the cutting of sawtimber or other products at the period of maximum annual or periodic monetary returns.

The age at which a stand reaches its capacity for maximum increment or

[1] As defined in Bul. 24, N. C. Geological and Economic Survey, "Loblolly or North Carolina Pine," by W. W. Ashe, 1915.

maximum monetary returns varies with the class of product. If it were possible, in a stand at the point of maximum periodic increment, to remove at the end of each year or other definite period the increment which accumulated during that period, the stand in theory could be continually maintained at this high point of production. To do this in the case of the stand presented in the accompanying graph would increase the annual production per acre of cordwood from 1.6 cords to 3.1 cords; the production of sawtimber from 410 board feet to 1005 board feet; and the value of sawtimber from $5.10 to $9.50.



GRAPH 1.– RELATION OF MAXIMUM PERIODIC ANNUAL INCREMENT TO AVERAGE ANNUAL INCREMENT FOR CORDWOOD, SAWTIMBER & VALUE

CORDWOOD INCREMENT ——— Maximum Periodic, – – – Average Annual } Read Yield in Cord

SAWTIMBER INCREMENT ●●●●● Maximum Periodic, ooooo Average Annual } Read Yield in Board Ft.

VALUE INCREMENT ✱✱✱✱✱ Maximum Periodic, xxxxx Average Annual } Read Yield in Dollars

It is realized, of course, that it is impossible to maintain any stand at the point of maximum annual increment. The ideal all-aged stand developed by means of selection fellings falls far short of this desideratum. In such a stand the old trees have low increment, far below the maximum annual increment of an even-aged group, and there are areas occupied by very young groups which will not be able to utilize fully the capacity of the soil. The root zone of the older trees, however, occupies a larger proportion of the soil in the all-aged stand than in the even-aged stand. The more complete utilization of soil productivity is, of course, one of the advantages held out by selective cutting as compared with clean cutting.[2] In order

[2] Count C. D. F. Reventlow, the Danish forester-statesman, as far back as the first decade of the nineteenth century, in his Prin-

to secure this advantage it is necessary that the optimum growing stock be maintained at all times. This optimum would be represented in the case of the examples given in the graph by 2300 cubic feet per acre as a growing stock in the case of cordwood production, at an age of 20 to 30 years; 4500 cubic feet in the case of a stand being handled for the production of sawtimber regardless of value, at an age of 35 to 50 years; and 6400 cubic feet (29,000 board feet) at an age of from 50 to 70 years in order to obtain sawtimber of the maximum value.

Clean cutting or clean cutting with seed trees is a simple—almost mechanical—process. It is the process which requires the least judgment; it is the easiest way. It largely does away with the silvicultural problem of light and the adjustments of light to restocking by natural methods. It is easy at all times to determine growing stock; thinnings can be made progressively. It permits cheap logging. While it is the method of least resistance, it is also schematically the most perfect. It is a system, however, which does not lend itself to the production of large-sized timber except at enormous cost. It is a system which continually brings up the irritating questions of interest and carrying charges. It is the system which in the end produces the lowest financial returns; and, finally, under continuous practice it is the system which on many sites may lead to rapid deterioration of soil, if the experience of Saxony with its even-aged pure stands and declining yields is a fair example.

A comparison of the clean-cutting system and selection fellings was clearly made by Dr. Henri Biolley in one of the outstanding papers in the field of practical silviculture presented at the World Forestry Congress[3] held at Rome in 1926. Dr. Biolley discussed some results from handling certain Swiss forests under the selection method of cutting compared with results from clean cutting on a site of like quality.[4]

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ciples (No. 15) stressed the necessity "of utilizing the soil to its fullest" by not removing too much at one felling. Opperman: Journal of Swedish Forestry Society, 164. 1928.

[3] L'orientation de l'aménagement des forêts en Suisse. Actes du 1er Congrès International de Sylviculture, Vol. 4: 19-29, 1926. Dr. Biolley was at that time chief inspector of the forests of the Swiss Canton Neuchâtel, having previously served for many years as inspector in charge of the Arrondissement Val de Travers, "the renown of the forests of which is today, thanks to him, world-wide." In the summer of 1927 he was retired at his own request, on account of poor health, at the age of 66 years. His motto was, "The best possible in quantity and quality." (Roger Ducamp in Revue des Eaux et Forêts, Sept., 1927, pp. 489-491.)

[4] An opinion contrary to that drawn by Biolley from his observation of the stands described is stated by Troup in his Silvicultural Systems, p. 114, as follows: "That the outturn of sawtimber of forests worked under the selection systems is smaller than that obtained from forests worked under even-aged stands"; and further that the wood produced under the selection system is more knotty than that produced in even-aged stands and has, furthermore, wide irregularity in its grain.

In this connection a statement by A. Möller is pertinent. This is that a clean-cutting method as compared with a continuous canopy method (selection or modified shelterwood) keeps one-fourth of the soil unproductive so far as timber production is concerned. (R. C. Hawley's review of literature relating to Dauerwaldwirtschaft, Jour. of For. 20: 651-661, 1922.) Möller's conclusions

He shows that the stand under selective felling was producing trees having an average diameter of 65 cm. (26.6 inches) and that 49.2 per cent of its product was material having a minimum diameter inside bark of 17 cm. The even-aged stand handled on a rotation of 100 years (the trees when cut being 60 to 100 years old) was producing trees which had an average diameter of 27 cm. (11 inches), while only 28.4 per cent of its product was wood more than 17 cm. in diameter. The yield of the selection stand was 20 per cent less than that of the even-aged stand. He does not give relative values.

In the case of southern-pine timber a stand averaging 11 inches in diameter is barely within the merchantable class and a stand having an average diameter of 26.6 inches has a value around $12 per 1000 board feet. Or allowing for a yield of only 20 per cent less than of the even-aged stand, the relative values would be about as $1 to $9.60 for the sawtimber material only. An example of comparative values likewise may be taken from hardwoods. A trade organization advertising for ash logs offers $25 per 1000 board feet log scale for logs 14 to 16 inches in diameter and $35 for logs 19 to 23 inches in diameter. With the cost of delivery of timber in either case at $20 per 1000 board feet, log scale, the addition of 6 inches to the diameter of the logs triples the stumpage value of the larger timber.

One of the significant omissions in Dr. Biolley's paper is that no mention is made of the age of the trees which are being produced in the selection stand. He is not interested in their age—age, in fact, becomes a matter of indifference, since fellings are periodic, average annual yield is large, and quality of timber is better than that produced in even-aged stands. Why worry about age, he queries; why even mention this disquieting factor with its train of carrying charges? He in fact essentially abandons age and rotation period as principles of management.

It is realized, of course, that there are limitations to the employment of selection felling and that there are cases in which progressive fellings are not without drawbacks. The limitations are due to (1) inadaptability of species to this method of management; (2) character of logging operations, requiring or seeming to require heavy cutting; (3) characteristics of stand which seem to offer no opportunity for selection fellings.

Even with these limitations there remains a broad field[5] within which it

were based upon a method of cutting which he had put into practice over a period of 29 years on his forest of Scotch pine on sand soil southwest of Berlin.

[5] A number of West Coast species are clearly suited to selection felling, although the large size of the trees in many existing stands may be a bar to its general application. There are of course exceptional conditions, as when exposure of the mineral soil or full light are required for replacement—when, for example, in a mixed stand reduced light or humus soils unduly favor the less desirable species. White pine in the Northeast (less so perhaps some of the Lake State races) is clearly well suited to the selection system. In the Southeast where the theory has been generally held that clear cuttings must rule there has accumulated thoroughly convincing evidence, even in the case of longleaf pine, after two years of intimate association with this tree in the region of the Gulf Coast where best developed, that except on the lower quality sites, it is preëminently adapted to group selection management, not only for poles and sawtimber, but for turpen-

may be said that selection or group selection felling or a series of partial fellings offers the most rational method of management. It is preëminently the system for farm woods and for small estates, and in many cases it is adapted to larger units. During the past 10 years the truck not only has become a most important factor in portable sawmill operations but has come to be employed extensively in connection with larger band operations. A double-band mill at Plainview, Arkansas, was logged on one side for two years by truck, the logs being hauled a distance in excess of 25 miles. This would have continued if more timber had been available. A large hardwood mill at Macon, Georgia, largely supplies its log needs by means of trucks. The use of trucks or of trucks supplemented by caterpillar tractors means greatly reduced construction costs. In fact it means the conversion of a general construction expense into an expense that varies with the diameter of the tree. To put the practice of selection fellings into effect or even to use partial fellings would in many cases result in increased logging costs; but its relative merits and possibilities cannot be determined without an analysis of operating costs, for it may imply a proportionately greater increase in the selling price of lumber.

Numerous papers dealing with the subject of logging costs[6] have had as their chief objective the development of methods of partial felling which would approach the selection system and point the way to developing a more remunerative method of handling woodlands that can be obtained by clean cutting with seed trees and might lead to placing lands upon the basis of management for permanent yield.

In certain classes of stands there is a noticeable deficiency of small trees. But even in the case of stands in which all the trees seem to be old and of large size, it is often possible to select a class of younger trees the cutting of which could advantageously be deferred. Certain species, also, are not windfirm even when partially isolated; some suffer ill effects as a result of insolation; others are not adapted to all-aged stands, or are not adapted to being handled in this manner when growing upon certain sites. It is evident, however, that there has been an exaggeration of the conditions to which it is assumed that heavy fellings and even-aged stands are best suited.

Now the objection will doubtless be raised by some silviculturist that the cultural practice of thinning cannot be so effectively carried out in uneven-aged stands as in even-aged stands, that there is less opportunity of accelerating growth. This is true to a certain extent; the area upon which thinnings must be carried on each year is more diffuse and more judgment is necessary for their execution. At the same time the short periods which would elapse between the cuttings of mature timber, seldom more than two decades, open up many possibilities.

But apart from purely pragmatic considerations there are reasons which might be called psychological for advocating

tine production as well. Slash pine and shortleaf pine naturally occur in all-aged stands and loblolly pine lends itself to all-aged systems except upon poorer quality sites.

[6] Ashe, W. W. Cost of logging large and small timber. For. Quart. 14:441-452, 1916.

Alabama Forestry Commission, Bulletin No. 2, 1929.

Zon, R. and C. D. Garver. Selective Logging in Northern Wisconsin, 1928.

selection and partial fellings. Advocacy of these practices holds out to the timberland owner the expectancy of an early recut and the possibility of producing timber of a high grade, timber which will command the highest stumpage price and with relatively low carrying charges on the investment. In this way it arouses the interest of the owner in his property as an investment, leaving aside the depressing subject of the age of mature trees.

For many years, in discussing with owners the methods of handling woodland, I have carefully evaded referring to the subject of age of trees. Why start out by discouraging a possible "client" with a consideration that is after all a secondary one and can usually be ignored? If an owner is once brought to recognize that the earning value of his property depends upon a reserve of timber, he may be induced to cut so as to maintain this reserve, which he will come to view as being as much a part of the capital investment as the land itself.

A manual of woodlot management recently published by the Illinois Division of the Natural History Survey is one of several such publications that seem in various ways to fall short of presenting adequately the selection system or the interest of the landowner in partial felling. In this publication of 194 pages the introductory statement is made that the system generally best suited to the woodlot is the selection system; yet only six pages are devoted strictly to the selection method. This publication presents a pointed discussion of management for the production of ties. Why are no similar methods adduced for cutting for sawtimber and for veneer stock, both of which are certainly high-priced materials; and why lessen the interest of the timberland owner for whose use this manual is evidently intended by bluntly stating that for the production of veneer stock "150 years are required for taking 80 trees per acre to maturity?" Why not rather call attention to the fact that by applying to existing stands the selection system of cutting one high-grade veneer-stock tree can be produced every two years when the stands have been fully developed? Why not rather in the case both of veneer and of sawtimber indicate the periods which would elapse between fellings to secure high-grade material of both classes of products?

A similar case is presented in extension circular No. 249 of the University of Arkansas. This publication was designed to explain methods of handling stands of shortleaf pines for pulpwood production. A rotation of 20 years is advocated, with cutting intervals (partial fellings) of 10 years. It is stated that "a longer rotation than 20 years would be more profitable," but a method of handling stands with the view of obtaining this more profitable return is not developed.

The longer rotation would clearly be the more profitable. With larger trees there would be less material below 4 inches in diameter (the minimum acceptable commercial size for a stick). By cutting nothing below 12 inches in diameter, in place of 10 inches as fixed for the minimum diameter with the 20-year rotation, a larger growing stock would be maintained, and a higher average annual yield would be obtained. Cutting intervals would remain 10 years; there would be no increase in carrying charges; and the yield would be increased by at least 20 per cent above

that to be obtained by the method advocated.

Even plans for specific tracts fall short in this particular. An assistant state forester recently requested comments on a plan designed for handling an exceptionally fine stand of hardwoods upon an excellent site. The plan provided for cutting to a minimum diameter of 12 inches. The larger timber was suitable for high-class veneer stock and the highest grades of lumber. There was no statement as to the period before another cutting of equal value could be obtained. The point may be made that the owner desired to liquidate. But at least he was sufficiently interested in the investment value of his property to seek a cutting plan. An alternative management plan might have been submitted designed for developing more fully the earning value of the property in place of reducing its earning value to that of a tie proposition by leaving only trees below 12 inches in diameter.

In the face of cases of this kind is it a cause for wonder that landowners are apathetic as to the possible profits in handling woodland and that they continue to liquidate completely, "take the cash, and let the credit go," and by so doing materially lessen if not destroy the earning values of their properties—later to be rehabilitated at public expense or through subsidies?

OUR SOFTWOOD COMPLEX

ITS RELATION TO THE PULPING OF HARDWOODS

By ALEX. R. ENTRICAN

Engineer in Forest Products, New Zealand State Forest Service

The Softwood Complex

If I were to play the game strictly according to Hoyle I should, of course, delve into Freud and Jung for an exact definition of a complex, but to see me wandering in the field of abnormal psychology would probably appear as only a pose, so I must fall back on a more topical approach to my subject.

The Anglo-Saxon is said to suffer from a swollen head. The moderns call it a "superiority complex." The Nordic, too, is claimed to have a "superiority complex." The moral is that the Anglo-Saxon or Nordic has so long been top-dog that he believes he will forever remain so without any special effort. Freud would probably tell you that the constant repression of the fear that he will lose his supremacy accounts for this state of mind; but a simple, although more superficial, explanation is that his mind has become so involved with past achievements that he neglects contributory causes and loses his perspective. That is a "complex" in the sense I wish to use it. Its danger is self-evident.

Now take your library catalogue and under "Softwood Resources, etc.," the card index will list innumerable references in many languages and in every sort of forestry publication. "Softwood Resources—The Crux of the World's Forest Problem" is a title typical of many. You can call to mind others similar. North American foresters have contributed quite a number. True, hardwoods have come in quite recently for a little more than their ordinary share of attention, but nevertheless the underlying problem of the country's wood supplies still appeals to most foresters as lying in the province of the softwoods. Herein lies the softwood complex.

Causes of the Softwood Complex

One of the basic causes of this softwood complex has been undoubtedly the restriction of the important coniferous forests to the northern hemisphere, from which practically all advances in modern civilization have sprung. Coupled with this fact has been an unfortunate tendency to overemphasize, or rather give primary importance to, the so-called direct benefits of the forest, that is, to its function as a supplier of wood products. Fundamentally agriculture is the first consideration of man, and the forest, in conserving streamflow and stabilizing the soil, finds its primary usefulness as an aid to agriculture. Under these premises forestry resolves itself into a land use problem, and clearly species must be fitted to the soil, a principle which undoubtedly should reduce the importance of the softwoods.

Most certainly the softwoods must figure prominently in any solution of the

North American problem just as they must figure prominently in the world situation, but most authorities appear to evaluate the position of the softwoods in the future of forestry solely upon the most primitive conception of wood use, without a weighing of past conditions and without taking into account present trends in wood utilization. I say "the most primitive conception of wood use" advisedly, for it has lasted through countless years until the present day. Our New Zealand Maoris, no doubt like the American Indians, demanded two basic properties of their important woods other than fuelwoods—that the wood be easy to work and (or) durable. Both properties, you will observe, contribute to economy of labor. Woodworking, even with the best of stone implements, was arduous, and it was logical to prefer durable woods so that the finished article would last as long as possible. That is why our very durable totara (*Podocarpus totara*) has been so universally employed for the ancient carved houses seen around the famous Rotorua Thermal District.

This concept of wood use has changed little in recent times. While an overplus or perhaps an apparent overplus of forests existed, the durable and easily worked woods continued to be exploited to the exclusion of all others, but, as supplies have become scarce and prices have risen in sympathy, the less durable and less workable woods have been more widely used. This progression in wood use is well illustrated in New Zealand, where rimu or red pine (*Dacrydium cupressinum*) has succeeded kauri (*Agathis australis*), and in Australia, where the Queensland conifers were exploited ahead of the predominating eucalypts. In both countries, too, the durable and easily worked imported woods from North America are often preferred to the local woods, which are not only usually more costly, but often either less durable or more difficult to work. Where only hardwoods have been available, it has still been the more easily workable and durable species which have been exploited first.

World's Timber Shortage More Apparent Than Real

The outstanding result of our softwood complex has been to give foresters overmuch concern regarding the world's future wood supplies. Many competent authorities have issued more or less alarming statements regarding the shortage of softwood supplies and its attendant dangers. Even the most hopeful consider the world to be overcutting its annual softwood yield by over 25 per cent. I am prompted, however, to be somewhat doubtful of many of these fears, for the following reasons:

1. Foresters are notably conservative in estimating growing stock, and each succeeding survey of large areas shows the forest capital and (or) forest increment to be much larger than commonly anticipated. Two recent instances of this are Sweden and Canada. In addition the exhaustion of virgin softwood stands tends to change the psychology of sawing from that of quality to one of quantity, with a very considerable reduction in wood waste and a corresponding expansion in supplies available.

2. While new countries generally fail to reforest or to practice forest management until forced to do so by acute shortage of wood supplies, older countries are quick to appreciate the world's situation

and make provision to meet not only their own requirements but also those of other peoples.

3. More important still is the present trend in wood use. Excluding fuelwood, practically the whole of the exploitable volume of the forest has until recent years been converted by sawing or hewing. Each year, however, an increasing proportion is being used by the pulp and paper interests and by a group of industries which, for want of a better name, will be referred to as the " disintegrated " wood industries. This trend has the immediate effect of materially increasing available supplies, since utilization of this type is much closer than that commonly attained by sawing, hewing, etc. Not only will a large portion of the logging, milling, and remanufacturing waste of the present commercial species be avoided, but many of the so-called non-commercial or " weed " species will become available.

Other contributory factors include the following:

1. The European peoples tend to become more widely diffused over other sections of the globe, and it is quite conceivable that with migration to both North America and the Southern Hemisphere the total population of that continent will become practically stationary. At the same time many European countries previously without any constructive forest policy are making an aggressive attack upon their domestic wood supply problems, and with the ever-increasing nationalism of their colonies and dependencies, the export of manufactured forest products will tend to decrease. The net result should be a surplus of raw or semi-manufactured forest produce for export to the increasing populations of the tropics and the Southern Hemisphere, as a supplement to the native hardwoods, the uses of which are now rapidly expanding.

2. As countries mature, they gain a better appreciation of the indirect benefits of the forest and of forestry as a land use problem in which the species must be fitted to the soil, a tendency which will give hardwoods a wider silvicultural significance and tend to develop their wider exploitation.

3. The art of wood preservation has advanced to a point where it is commencing to influence the management of both softwood and hardwood forests, making available woods hitherto useless; and again expanding available supplies.

4. A constantly expanding network of cheap transportation systems, together with improved living conditions for white labor in tropical countries, is having the effect of bringing on to the world's markets new hardwoods in large quantities.

All these are hopeful factors and claim more attention than has hitherto been paid them. Of course you may well ask, " But how are these hardwoods to be used in competition with or in place of the softwoods? " As a matter of fact I do not anticipate they will ever be used as widely as the softwoods, except perhaps in certain tropical and subtropical countries where geographical isolation and climatic and soil conditions may favor their almost universal use. At best they will provide only a supplementary supply for the softwoods, their relative importance being determined by the usual economic considerations of land use and special wood properties.

Wood Use Picture of the Future

To merge all these trends into a national scheme of wood use for the future, it is first necessary to accept the principle that the disintegrating methods of wood utilization will become almost as important as the present mechanical methods of sawing, hewing, etc. For want of a better term, I use that of " disintegrating methods " to include all processes involving the breaking up of wood, whether by mechanical or chemical methods, into small bundles of fibres or into the individual fibres themselves, and their recombination into desired shapes and forms. Disintegrated wood is even today being produced, molded, and made into paper, fibre containers, wall boards, box boards, reinforced wooden beams, sedan tops for motor cars, milk bottles, and innumerable other products.

The proportion of the world's merchantable logs absorbed by these products is admittedly small, but is constantly increasing, and when considered by some of the more important forest countries reflects clearly the wood use picture of the future. Take Sweden, for instance. Before the War its sawmills used annually 530 million cubic feet of wood, compared with only 175 million cubic feet consumed by the pulp industry, whereas today the respective figures are 495 million and 425 million cubic feet. In America, too, although the statistics are not so startling, the research and development work in the directions indicated is nothing short of staggering. Acceptance of this principle of future wood use has the immediate effect of reducing in importance the two properties of workability and durability, so that the number of species both of softwoods and hardwoods and the total cubic volume of usable material will be largely increased. Let us examine its effect upon our forest problems.

The ruling fetish of wood use is " clear lumber." It has long held sway on account of the fact that as one source of virgin softwood supply has failed, another has come into being. Only one, however, that of Siberia, is left, and the forester concerns himself more than ever before with pruning and other silvicultural operations calculated to yield as high a percentage of clear material as possible. To do this he often makes considerable sacrifices of increment and complicates his financial problems. This, however, should not be necessary in the future.

I picture rather the management of softwood stands, especially in temperate climes, to produce high increments and poor quality, that is, knotty logs, for which the psychology of sawing will be one of quantity rather than of quality. The basic use of this material will be not only for casing and boxing purposes but as core stock for the mounting of clear veneers cut from the virgin hardwood forests in various parts of the world. In other sections, as in Australia, where the internal stresses in many hardwood logs preclude their utilization by sawing, the disintegrating method of utilization will supply the necessary core stock and also innumerable molded and shaped products at present manufactured from mechanically sawn wood. Probably, too, the greater part of the waste produced by mechanical sawing will be converted into pulp and paper and into molded and shaped products.

Summarized, we may say that the wood use picture of the future shows,

first, fabricated and built up products, and second, shaped and molded products. Some of the processes involved have already become economic and are in use. Doors of built-up softwood cores and hardwood veneer faces are indeed in common use. Other processes are becoming rapidly so, and in Australia, where wood prices have probably mounted higher than elsewhere, important developments in the disintegrating method of utilizing hardwoods should be looked for. As an illustration of the possibilities involved and the basic economic facts supporting the argument, consider sedan tops for motor cars. Hitherto these have been constructed of many pieces of wood laboriously bent, shaped, and put together with several coverings of cloth, artificial leather, etc., all being subject to fairly rapid wear and deterioration. Now they are being molded from disintegrated wood with only a fraction of the labor hitherto employed and at the same time made more serviceable. It should not be forgotten either that all such distintegrated and molded products are susceptible to a 100 per cent preservative treatment.

Our two old friends, the basic properties of primitive wood use—workability and durability—achieved a desirable fundamental result in economy of labor. I have propounded another principle of wood use which achieves the same result in a still higher degree, and at the same time achieves a measure of forest economy which promises to simplify our forest problems of the future.

Use of Hardwoods in the Pulp and Paper Industry

Like many other fields of wood use, however, the pulping industry has been permeated by the softwood complex, and as this is representative of the oldest and as yet the most important disintegrating method of civilization, it is instructive to examine the bearing of recent studies into the pulping of hardwoods made by the Madison Forest Products Laboratory for the New Zealand State Forest Service.

SOFTWOOD AND HARDWOOD FIBRES

Mention hardwoods to the average pulp and papermaker and you win a pitying smile. He knows (?) that the only hardwood suitable for pulping is aspen (*Populus tremuloides* and *P. grandidentata*), which reduces by the soda process to yield a bulky and opaque pulp suitable for book paper. But any other hardwood by any other process to yield any other paper is impossible. He knows (?) why. Softwoods yield a slender fibre about 3 mm. long and of approximately a uniform cross-section throughout its length. This shape lends itself to good felting or interlacing of the fibres on the paper machine wire, and so gives good mechanical strength, particularly in tearing, to the finished paper. How can a short bulky hardwood fibre only about 1 mm. long, thick at the center, and tapering away sharply to its ends like a torpedo, possibly felt on the wire to yield anything but weak papers?

There is a "nigger in the wood pile" of course. Let us search for it in the five manufacturing stages—logging, wood preparation, pulping, processing, and paper fabrication—into which papermaking may be divided.

LOGGING HARDWOODS

In the logging field the felling of hardwoods presents little difficulty, and while few species are floatable, reasonable transportation costs are often avail-

able. One prominent Canadian paper company, for instance, states that with the utilization of the hardwood content of its mixed stands it can secure cheaper transportation for both its softwoods and hardwoods by substituting rail haul for river driving. Another prominent North American company has already cut its softwoods costs by this method of transportation, so that the logging of hardwoods has economic possibilities.

PREPARATION OF HARDWOODS FOR PULPING

Likewise in the wood room of the pulp mill sawing, splitting, barking, cleaning, and chipping of hardwoods are, generally speaking, accomplished with ease, sometimes more so, sometimes less so than with many of the softwoods, in which branches and bark tend to be more persistent and the ends of billets more liable to "brooming" or fraying. Balancing the various factors, there seems little doubt that the two kinds of wood behave about equally well in the preparation of the material for pulping.

PULPING OF HARDWOODS

Chemical Pulp. Certain fundamental considerations have long appeared to favor the pulping of hardwoods by the standard soda (alkaline) process rather than by the standard sulphate (alkaline) or sulphite (acid) processes. Recent modifications of the standard sulphite process and the development of a monosulphite (neutral) process, however, have opened a new field for the utilization of hardwoods. L. R. Benjamin, of Australia, for instance, has achieved signal success in the sulphite pulping of eucalypts, while the Madison Forest Products Laboratory has successfully reduced a number of North American hardwoods by both modified standard sulphite and monosulphite processes. This laboratory, in coöperation with the New Zealand State Forest Service, has also produced a satisfactory grade of sulphite pulp from tawa (*Beilschmiedia tawa*). As all its tests have been reproduced on a commercial scale, it may fairly be assumed that the pulping of hardwoods is an accomplished fact. Several mills are already operating on North American hardwoods, and it is interesting to learn that a pulp mill in Portugal is using locally grown Tasmanian blue gum (*Eucalyptus globulus*) to produce a high grade commercial pulp.

Mechanical Pulp. In the field of mechanical pulp, or ground wood, so called because it is prepared by pressing a billet of wood against a rapidly revolving grindstone which rubs off the wood fibres, the hardwoods are not as useful as the softwoods. The process damages the fibres considerably, so much so that even the softwoods yield fibres with an average length only about one-third their original length, but still with sufficient strength to enable them to be used for the manufacture of newsprint, in as high a proportion as 75 per cent of the total furnish. Mechanical hardwood pulp, produced as it is from short-fibred woods, has about only half the strength of softwood mechanical pulp. In fact its fibres are so fine and short that their strength is often regarded as negligible, and the pulp is useful primarily as a "filler" to give a better surface to papers and to improve their opacity, both very desirable properties in a paper pulp. The proportion usable in newsprint at present appears to be about 40 per cent of the total furnish.

Economic Considerations. The economics of hardwood pulp conversion appear attractive. The percentage yield of pulp based on the oven dry weight of the wood is as good as that attained in the pulping of softwoods, but since the hardwoods are commonly 20 to 30 per cent denser than the coniferous pulpwoods the yield per cord is correspondingly higher. The production from a given sized digester will also be increased in the same proportion, so that both the initial investment and the operating, maintenance, and depreciation charges will be reduced. Compare white spruce (*Picea glauca*), for example, with black gum (*Nyssa sylvatica*). The softwood weighs 24 pounds per cubic foot, oven dry, and runs say 85 cubic feet to the cord; while the hardwood weighs 30 pounds per cubic foot, and runs say only 75 cubic feet to the cord, so that if both have a yield of 45 per cent the white spruce produces about 920 pounds of pulp per cord and the black gum 1010 pounds per cord. The digester capacity in cubic feet for cooking black gum would also need to be only 80 per cent of that necessary for the production of an equal amount of white spruce pulp.

PROCESSING OF PULP

Because few papers other than book have been manufactured from hardwood pulps it must not be thought that pulp and paper operators have failed to attempt the utilization of the hardwoods so often forming an important constituent of their forest limits. Many attempts have been made and many fine hardwood pulps produced, but in trying to convert the pulp into paper, failure after failure has resulted. In the recent New Zealand State Forest Service studies the Madison Laboratory, too, produced satisfactory pulps of various descriptions. First it produced a strong insignis pine (*Pinus radiata*)[1] sulphite pulp which, although not quite as good as spruce in color, would give good tearing and bursting strength to a paper. Insignis pine yielded, too, a stronger ground wood than spruce, and while dirtier and more yellowish in color still appeared usable. The dirt, of course, originates both in the knots and in the core, principally in the latter, which is often characterized by a pith rot sometimes as much as ¾ of an inch in diameter. The "dirt count" would certainly be much lower if this core or pith rot could be eliminated by seed selection or fumigation, or by a study of soil conditions, preparatory to establishment. It is curious to note that blue-stained insignis pine yielded a better colored mechanical pulp than clean wood.

From tawa a satisfactorily colored pulp was secured both by the sulphite and mechanical processes, but both were weak and would not form a sheet of paper in their natural state. Still it was known that the strongest of fibres, those of sulphate spruce, were also weak in their natural state, and that to make them into kraft or strong wrappings it was first necessary to roughen up their surface so that when felted and interlaced they would not easily pull apart. This process is known technically as "beating," and the practical question was, "Can tawa fibres be processed to secure the same effect?" The fact that the tawa and hardwood fibres are very short complicated the beating operation, for the usual equipment was unsuited to the

[1] Better known in the United States as the Monterey pine of California. It has been extensively propagated throughout New Zealand.

purpose on account of lack of delicate adjustment and operation.

The Madison Laboratory, however, had previously developed a refining rod-mill for use with its semi-chemical process, in which the wood chips are merely softened in the digester and later placed in this revolving drum with tumbling rods to break up the softened chips into the individual fibres. By adjustment of the speed of revolution, the weight of the rods, and the consistency of the pulp, very delicate control of the beating operation is secured. When tried out on the tawa sulphite pulp, the process was found not to roughen up the fibre surfaces but rather to "hydrate," or in other words to create a gelatinous film which promised to give an adhesive effect in place of the interlacing effect secured with the longer softwood fibres. Failure to appreciate the possibilities of this processing treatment has therefore been the "nigger in the wood pile" of hardwood pulp utilization.

PAPERMAKING

No difficulty, of course, was experienced in combining the insignis pine sulphite and mechanical pulps to yield a standard newsprint of the required strength qualities, and although more yellowish in color than the best spruce newsprint, it was quite as good as many commercial newsprints, especially those produced on the West Coast of the United States.

Finally, too, with the perfection of the processing treatment already described, it was found possible to fabricate a newsprint containing 50 per cent of the processed chemical hardwood pulp, 35 per cent of mechanical hardwood pulp, and 15 per cent of softwood sulphite. The purpose of the softwood pulp was to give the paper good tearing strength and to help the sheet over modern papermaking machines running at high speeds, the bursting strength being contributed largely by the chemical hardwood content. Now sulphite pulps are notably translucent, and the remaining 35 per cent of tawa mechanical pulp supplied accordingly the deficiency in opacity and improved the surface of the sheet so that the resulting newsprint was better than standard softwood paper in practically every regard.

By the semi-chemical process it was also possible to secure from tawa the highest grade of fibre and container board pulp.

Conclusions

Here, then, are two achievements in the utilization of hardwoods by one of the most important disintegrating methods of wood use. They are only the forerunners of many others, and there seems to be little doubt that in our wood use picture and our forest problems of the future the hardwoods and softwoods must play a more balanced part. We have a real problem in New Zealand, where the hardwoods constitute 40 per cent of our virgin supplies, but contribute only 3 per cent of our annual cut. By the wider use of hardwood flooring, etc., we hope to improve this position almost immediately, but still we shall be drawing upon our softwood capital and must bend every effort to finding a solution of the problem. The position in North America is not quite so serious, but there appear to be several regions in which a solution of the local forestry problems will lie in the directions indicated.

STATEMENT OF FORESTRY POLICY

BY THE BOARD OF DIRECTORS OF THE NATIONAL LUMBER MANUFACTURERS ASSOCIATION[1]

Need for a Definite, Constructive, and Aggressive Program of Forestry

The lumber industry has the greatest stake of all in the forest future of the country since it owns practically half the forest acreage and is intimately concerned with the other half, whether public or private, as a means of perpetuating the sources of its livelihood. Therefore the National Lumber Manufacturers Association logically should take the initiative in formulation of policies affecting the care and management alike of public forests and of private timberlands.

The lumber industry has an enviable record of accomplishment in the development of manufacturing processes and logging engineering methods. It is gaining an equally enviable record through its national and regional lumber trade extension campaigns and otherwise, for progress in self-regulation and toward modernization of the merchandising and distribution of its products. We must soon look for an increasing proportion of our timber supplies hereafter, to man-grown forests. There is sound reason that the lumber industry should lead rather than follow in the development of commercial forestry. That it should do so is in the interest of economic progress and of national welfare.

In order, therefore, is a thought-out, definite, constructive, aggressive forestry program for the stimulation and guidance of forest land owners and for the education and inspiration of their wood-loving fellow citizens.

[1] Adopted by the Board at Longview, Washington, August 8, 1929.

Forestry Program for the National Lumber Manufacturers Association

I. Commercial Forestry

Commercial forestry, the business of growing crops of timber on private land, is governed by economic conditions and the returns anticipated. It can be greatly promoted by public understanding and coöperation, or retarded by the lack of them. It cannot be forced beyond the bounds dictated by prudent and responsible business management of timber properties. It must be economically self-sustaining.

Gratifying progress in the last 10 years has been made by lumber companies in the application of forest-growing principles to the logging and management of timber lands. Many have found it profitable to hold land for the growth of new crops; to intensify fire protection; to change logging methods to avoid undue injury to growing trees; to replace clear cutting with selective logging; and in some cases to replant logged-off areas. With continuing improvement in fire protection service; steady progress in several states toward solution of the taxation problem, stabilization of markets, and uses for lumber and diversified wood

products; through organized trade extension, and increasing scientific forestry knowledge acquired through diligent research; the possibilities of profit in commercial timber growing are expanding.

Lumber manufacturers should stand ready to extend the practice of commercial forestry as far and as fast as dependably ascertained economic facts and prospects will warrant. The National Lumber Manufacturers Association, through its Board of Directors, therefore, urges upon each timberland owner who has not already done so that he make or cause to be made a thorough economic study and careful analysis of the forest-growing possibilities of his land holdings and that, in his future program of land use, management, or disposal he be guided by the facts thus developed and by sound affirmative conclusions properly drawn therefrom. To aid in such studies the Association offers the facilities of its forestry and other departments. It will put interested forest land owners in touch with persons or agencies available and believed to be most competent to conduct such studies. It urges the regional associations severally to join it in so doing.

No two timber properties are alike. Each one is a distinct forest problem in itself, to be worked out on its individual merits. It is by no means likely that all privately owned forest lands can be profitably devoted to timber-growing. In any case it is important to know the exact facts. Facts only will provide the basis for the determination of sound management, use, or disposal policy.

Among means of forest conservation and perpetuation applicable to differing situations, two are, we believe, deserving of special study by owners of forest land properties:

1. The possibility of operating existing stands of timber on the basis of selective logging; either by size of trees, species, timber types, or areas classified with respect to accessibility and logging costs; with a view to harvesting such timber in the order of its actual economic value, and reserving for future utilization the portions of such stands whose present cutting actually yields an unprofitably low return or a loss.

2. The practicability in many cases of organizing forest properties and manufacturing plants on a basis of sustained yield in cutting and manufacture, either of lumber or other forest products, or as nearly on sustained yield basis of cutting as local condition will permit. This may frequently involve the desirability of acquisition of additional areas of growing or young timber. In the case of industrial operations whose local situation justifies developments in this direction, an effective basis of stabilizing production and insuring permanency of operation may thus be afforded.

The practice of forestry offers the prospect of possible gain in one or more of the following ways:

1. Direct profit from the growing of successive timber crops: (a) by insuring sustained supply of raw materials; (b) by sale of stumpage, as it matures to commercial size and quality, on the open market; or (c) by giving the lands a higher sale value.

2. Avoidance of the dulling effects of public regulation.

3. A present aid to the profitable sale of lumber and other forest products.

Timber and lumber products that are known to have come from well-managed "sustained yield" forests will sell

more readily than those produced through logging operations which are commonly accepted as resulting in substantial forest destruction. The notion that every tree cut means that much additional forest destruction and that therefore the important way to help "save the forests" is to use less lumber, is surprisingly well-rooted in the mind of the consuming public. In the interest of continued lumber use and forest perpetuation, it must be supplanted by an accepted understanding that liberal and wise use of lumber and forest products is the essential, and the only secure, stimulus to forestry practice by private enterprise.

2. COOPERATIVE PROJECTS

1. *Acceleration of the coöperative and research activities already provided for under the Clarke-McNary and McSweeney-McNary Acts in order to expedite the elimination of the three principal man-made obstacles to profitable industrial forestry, viz.:*

(a) Excessive cost of protection from

(1) Fire.

(2) Insects.

(3) Disease.

(b) Improper methods of taxation.

(c) Ignorance concerning correct forestry practices.

Under the Clarke-McNary Law there is need for pressure upon Congress to build up federal appropriations to match those of states and private coöperators which are now proportionately outstripping them. In many of the more inactive states there is need for improved legislation and increased appropriations to establish and strengthen the state forest departments.

The coöperative principle of protection from fire should be broadened to include also protection from forest insects and diseases with equitable proportionate sharing of cost between the federal government, the states, and the forest owners.

The study of forest taxation and forest insurance authorized by the Clarke-McNary law should be carried vigorously to completion. Such studies are valuable largely in proportion to the speed with which they are brought to conclusions and their results made available for necessary state legislation.

Under the McSweeney-McNary Act the full program of forest research should be undertaken without delay. Emphasis should be placed on the importance of pushing to completion promptly the whole program as contemplated by Congress. Divergence of opinion upon the solution of our national forestry problems is due largely to lack of knowledge of our forest resources and our forest needs. We believe that with adequate federal appropriations a plan can be developed in coöperation with the state forest departments and the private interests involved under which proposed forest resource surveys can be brought to workmanlike completion within a comparatively short time.

2. *The development of a workable plan for stabilizing the lumber industry in order to conserve the remaining supply of virgin timber from the rapid and unprofitable exploitation to which it is now subjected, and to remove the deadening influence which the present situation imposes upon the spread of improved forest practices.*

This problem is of such seriousness, magnitude, and complexity as to require

in its solution the best thought available. It is of intimate concern to the lumber industry. By no means should leadership in its solution be left in other hands. It demands the early establishment of orderly means of industrial self-control. This is the paramount challenge the industry faces today. It demands coöperation with public agencies.

3. *Coördination of federal and state timber sale policies with the development and operation of adjacent or intermingled private forest properties.*

This problem is related directly to that of stabilization. The federal government with its National Forest stumpage, supplemented by the timber holdings of some of the states, holds balance of power in regulating the expansion, contraction, or perpetuation of lumber production. Some operations are already entirely dependent upon National Forest stumpage, some are partially dependent, and others must soon look to the National Forests for their supply of the future.

In our opinion controlling policies should be:

(a) To sell federal or state stumpage only at that rate necessary to maintain existing forest industries, or meet local requirements, on a sustained yield basis.

(b) Where there are adjacent or intermingled private forest lands, a sustained yield plan of cutting should be worked out and applied to the area as a whole.

(c) Adequate protection in securing such timber should be guaranteed operators on adjoining lands whose plans for a sustained rate of cutting meet reasonable requirements of public timber agencies.

4. *Increased fire protection appropriations for the National Forests.*

Congress has never adequately financed the protection of national forests. Annual expenditures per acre have averaged materially less than those for the organized private holdings in the western timber states. The lumber industry has a heavy stake in the welfare of the national forests since it must look to them for a large portion of its future stumpage supply. Congress should regularly provide sufficient funds to insure the effective protection of the national forests from fire.

5. *Expansion of public forest ownership.*

Of the total estimated forest-growing area in the continental United States, viz., 469,500,000 acres; 81,200,000 acres are held in the national forests, and 11,200,000 acres in state, county, and municipal forests and parks. In all, less than one-fifth of the total is in permanent public ownership. In the public interest the area of publicly owned forest should be greatly expanded.

Large areas in private ownership, in mountainous regions, are primarily valuable for watershed, and to some extent for recreation purposes. Such public value can be properly conserved only by a modification of ordinary commercial forestry practices and at an increased cost which private capital cannot and should not be required to bear. Forests of this class logically belong in public ownership.

There are other large areas, in various parts of the country, of sub-marginal forest lands which have too low a productive capacity to be profitable in private ownership or inviting to private enterprise. Such lands, *to the extent, if any,*

required by the public's ascertained needs for future timber supply, should be converted to public ownership and be managed accordingly.

While there is practically unanimous opinion that public forest ownership should be greatly expanded, nevertheless there is divergence of opinion as to details—just what lands should be taken over by the public, and whether the ownership should be federal or state. There is needed a nation-wide, comprehensive program for public forest acquisition, coördinating clearly the federal and state responsibilities and defining the classes of land and the particular areas accordingly to be acquired. The federal government and several of the states have made marked progress in their studies of the problem. The forest resources survey authorized by the McSweeney-McNary Law, will be of inestimable value in completing assemblage of necessary basic data.

The National Lumber Manufacturers Association offers its aid to the working out of such a program through the appropriate public agencies. In this, certain principles should in our opinion be observed:

(a) All federal lands chiefly valuable for national forest purposes, and not now under any form of permanent reservation, should be added to the national forest system.

(b) All lands, chiefly valuable for forest purposes, which have reverted to the ownership of the several states, should be promptly and permanently incorporated in the respective state forest systems. Reversion of lands to state ownership, occasioned by the imposition of annual tax charges in excess of the annual value of the land itself (which is a form of confiscation) should not be encouraged or stimulated. So far as practicable, by remedial tax legislation and conservative administration of tax laws, and by public coöperation, and profitable retention and management of forest lands in private ownership should be encouraged.

(c) The consolidation and extension of the western national forests, under the provisions of the General Land Exchange Law, should be advanced diligently and completed without unnecessary delay.

(d) Extension of the eastern national forests by direct purchase should be expedited.

The original federal acquisition program under the Weeks Law, which was initiated in 1911, contemplated the acquisition of some 6,000,000 acres of protection forests on the headwaters of navigable streams in the eastern mountains. This original program is as yet not more than half completed. Large additional appropriations are necessary. These should be provided.

The federal policy of purchasing watershed forests of national importance should be expanded materially beyond the limits set in the original program under the Weeks Law. Several million additional acres in the eastern mountains are needed and there are large areas of private land within the boundaries of, or adjacent to, the western national forests, which should be added to them. This task cannot be completed within any reasonable length of time under the provisions of the General Land Exchange Law alone. It must be supplemented by direct purchase on a large scale.

The Clarke-McNary Act and the McNary-Woodruff Act have extended the federal purchase policy and basic authorization beyond the limits of navigable stream watersheds into regions where the production of commercial timber crops is in effect the higher value. The National Lumber Manufacturers Association has heretofore endorsed and does now endorse this principle.

The U. S. Forest Service has carefully worked out a purchase program in the Lake States and the South. There is divergence of opinion as to how far the federal government should go in the acquisition of non-watershed forest lands. One point of view is that the federal government is the only agency to care for our forest land properly and thus insure the nation its future timber needs, and that therefore the more lands it acquires the better, of all classes and character, and in all parts of the country. Another point of view is that federal ownership of non-watershed forests should be limited to comparatively small demonstration areas serving primarily to lead the states to build up state forest systems of their own and to encourage the private owners to introduce commercial forestry practice. The nationwide, comprehensive, and concerted program for public forest ownership, urged above, will serve to reconcile such differences in opinion.

Hitherto annual appropriations for forest acquisition have averaged less than $2,000,000.

Whatever final federal acquisition program may be determined, obviously the necessary annual appropriation should be supplied. There can be no success in a non-supported program.

In federal acquisition of lands, east or west, by purchase or exchange, the primary object is clearly to acquire in the best possible condition such lands as can best contribute to the nation's forest welfare through federal ownership. The better the productivity, the better the bargain. Great stimulus may be given private management to maintain forest productivity by recognizing any lumberman's investment to such end and paying for such value received. This has not always been done.

(e) Each state which has a sound forest acquisition program should be given support and assistance in carrying out its plans.

(f) The Indian tribal forests, comprising some 6,000,000 acres, should be kept intact and managed on a sustained yield basis, under correct forestry principles, for the permanent benefit of their owners. These Indian properties are of great importance to the lumber industry as a source of timber supply, both present and future.

3. UTILIZATION

Added to all the above is the joint responsibility of private and public agencies to teach the consumer of lumber to be a *better buyer* of lumber so he will always know *when* to use lumber and *what kind* of lumber. The responsibility of manufacturer, seller, and buyer is for coöperative, intelligent use of this great national resource; as is also every plan and device for using by-products, and for treating lumber so that it may serve its best purpose. Forestry is intelligent lumbering. Intelligent lumbering recognizes forestry. Forest industry of today and tomorrow must serve both ends equally.

WORKING PLAN FOR EXPERIMENTAL THINNINGS IN SHORTLEAF AND LOBLOLLY PINES

By L. I. BARRETT and F. I. RIGHTER

Junior Foresters, Southern Forest Experiment Station

Introduction

ALTHOUGH experimental thinnings in shortleaf and loblolly pine have been made in practically all of the southern states, there has been as yet little standardization of methods and no full appreciation of the detailed problems involved. The few available publications on the subject present data based on a limited number of experimental plots, small in aggregate area and limited largely to local conditions.

The problem presented by a comprehensive thinning study is somewhat similar to that encountered in preparing yield tables. The yields under various methods of thinning, and the reactions of the remaining stand to the release from competition vary with age, site, and species. The basis for accurately determining the effect of thinning cannot be limited to the dozen or so experimental plots which are now available for furnishing such information on loblolly and shortleaf pine in the Gulf States.

The necessity for accurate information on the best thinning practice, the yields possible, and the cost of such work is becoming more and more apparent in the southern states. The increasing interest of paper pulp companies in the southern pineries is making possible the utilization of such small material that pine "thickets," once considered worthless, now constitute a substantial asset to the landowner.

There are 115 million acres of pine lands in the South capable, on the average, of producing a cord to the acre each year. The pulpwood requirement of the United States in 1950 has been estimated at 12½ million cords.[1] Assuming that the fuelwood requirement will be about the same as for pulpwood, and that the southern pineries will be called upon at that time to furnish about one-third of the Nation's cordwood requirements, only 8 to 10 million cords of southern pine would be needed annually for this purpose. *Therefore the ultimate objective of management in southern pines should be the production of sawtimber, not cordwood.* Thinnings alone could supply the cordwood demand. It seems advisable, therefore, that thinning experiments should look to the production of sawtimber as the final product.

The series of thinning plots established by the U. S. Forest Service in 1915 at Urania, Louisiana, has served as a valuable guide for further experimental work. These plots have been particularly helpful in demonstrating the kind and amount of data that are necessary for adequate evaluation of results.

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[1] E. H. Clapp and C. W. Boyce, 1924. How the United States Can Meet Its Present and Future Pulpwood Requirements. U. S. Department of Agriculture Bulletin No. 1241, page 27.

Theory and Purpose of Thinnings

The theory upon which the practice of thinning is based is that trees in overstocked or even in normal stands are in such severe competition for light and moisture that they do not attain the maximum growth compatible with the production of good quality material. Thinnings are designed to decrease this competition by removing the inferior trees which interfere with the best development of the better trees. This operation serves two main purposes: (1) it increases the growth of trees in the residual stand, thus shortennig the rotation; (2) it harvests trees which would otherwise die and be lost in the normal development of the forest, and removes trees which would continue to live at the expense of the larger, more desirable individuals.

Various other benefits may also come about. For instance, the removal of trees which otherwise would die tends to lessen the fire hazard; cutting out of weak trees, which might serve as a starting point for insect or fungus attacks, increases the health of the stand; thinnings can be made so as to produce annual rings of uniform width which should result in controlling the quality of the wood produced. It is possible also that soil conditions may be improved by thinning. A thinning may yield the landowner an income which he would otherwise lose; or it may enable him to hold the remaining stand for a future increase in value. All of these benefits, although of secondary importance, should be borne in mind.

Methods of Thinning

Two general methods of true thinnings as distinguished from cleanings or improvement cuttings, have been recognized in the past. The so-called German thinning was made from "below." Light thinnings removed only the dead, suppressed, and some of the intermediate trees; heavy thinnings removed all of the suppressed and intermediate trees and, in addition, a few of the codominant trees.

French and Danish thinnings are somewhat similar in that they are designed to favor certain dominant, well-formed trees selected for the final crop. These thinnings, however, are expected to yield considerable income by removing many trees of the dominant and codominant classes.

The light thinning made from below and generally known as the German method in this country is no longer looked upon favorably in Germany. In fact, the tendency in European thinning practice today is to thin more heavily in the upper crown classes; this reduces competition where it is keenest and gives a greater immediate yield.

A thinning is not a rigid mechanical process, and definite statements of what should be cut are difficult to make. Some leeway must always be allowed to meet field conditions and the variations due to the personal equation which inevitably enters into any method of marking practice. The methods of thinning given below are outlined with these facts in view, and a comparison of the various methods will in time give a much better idea of what constitutes good thinning practice.

From data based on the Urania plots (established in 1915 in second-growth shortleaf and loblolly pine stands at Urania, La Salle Parish, Louisiana) it has been found that light thinnings made from below do little to stimulate growth on the remaining stand. Moreover, the

yields from such cuttings are so low that there is little likelihood that this method will be used in actual practice. In the light of past experience and considering future requirements the following thinning methods are considered the most important for investigation:

1. German.

Grade C—Heavy thinning. Remove all intermediate and suppressed trees, but no dominants or codominants.

Grade D—Very heavy. Remove all intermediate and suppressed trees and, in addition, some in the codominant class which are offering the severest competition to the best trees. Not over 15 per cent of the codominants should be cut; an average of 10 per cent should be the objective.

2. French.

Grade A—Light. Remove all intermediate and suppressed trees of merchantable pulpwood size (4″ D.B.H. class and over); also larger trees which are offering harmful competition to the better dominants that will constitute the final crop. The cut should remove from 16 to 25 per cent of the dominant and codominant trees, with an average of 20 per cent as the objective.

Grade B—Heavy. The same as the "light" thinning, but with a heavier cut of 26 to 35 per cent in the two upper crown classes; a 30 per cent cut of the dominant canopy should be the objective.

Grade C—Accretion Cut. Designed for stands which are approaching sawlog size (when 35 to 45 per cent of the trees are 16″ or over D.B.H.) and which have never been thinned. The thinning removes all trees of merchantable size except 125 to 150 per acre of the best trees which form the final sawlog stand. This method of thinning should not be given equal weight with Grades A and B in the establishment of plots. The main effort should be toward the establishment of a sufficient number of plots in the younger stands. The Grade C method can be investigated to better advantage after the work on the other methods is well under way.

In stands which are 25 years or more in age the suppressed trees are large enough to furnish pulpwood material, and the German Grade D thinning will correspond in a way to the Modified French Grade A because practically all the smaller trees will be cut in either of these methods of thinning.

It is recognized that methods of thinning may be developed which are better suited to American economic conditions than are any of the European methods described above. Such methods will have to be evolved by experimentation, and it will be well to keep this in mind when thinning plots are established. Therefore it is suggested that methods other than those listed above—such as the Danish method—be included in the program, if personnel, time, and funds are available. The field of thinning is so broad that there is little likelihood that any investigative agency will be able to do more than scratch the surface for many years to come.

Recommendations for the removal of certain percentages of the trees in the dominant canopy have been based largely on an analysis of the Urania plots. It will be desirable, as the data accumulate, to express the degree of thinning in terms of the percentage of the total merchantable volume recommended for removal. This cannot be done until several more measurements have been made. After a

number of similar thinnings have been established in stands of the same age on the same site, it will be possible to make a general statement of the percentage of the total volume which should be removed for any method and degree of thinning specified.

The proper interval to allow between thinnings cannot be stated with certainty. This must be determined by increment borings and by inspection of the plots, as well as by the final results obtained from a great number of thinned plots. However, previous experience points to a 5-year interval for the German thinnings, and to a 10 to 15-year interval for the heavier grades.

If the French method of thinning is employed in stands under 25 years of age, trees too small for pulpwood are left standing. Some of these doubtless will die and be lost, but many of them will live to be cut at subsequent periods. This understory may help to keep down brush and grass and preserve desirable soil conditions. The idea of leaving small, unmerchantable trees is not new, being practiced by the French. Ashe[2] has advocated this practice for thinning southern pines. However, consideration of root grafting suggests that the light French thinning should be modified experimentally so that on some plots the trees which are too small for pulpwood will be cut. A check of the French method against this modification, or against a German Grade D thinning, may shed some light on root grafting as an influencing factor in the development of the stand.

Although an immediate financial return from a thinning is desirable, experimental thinning practice should not be dominated by that consideration alone. It is probable that here, as in Europe, the degree of utilization will become greater as our timber resources decrease, so that material at present unmerchantable will find a market and earn an immediate return on the investment. Hence, experimental thinnings may well be established in stands as young as 10 years. Moreover, thinnings ought not to be limited to stands which are old enough to yield merchantable material unless it can be demonstrated that thinnings in younger stands do not ultimately pay for themselves.

Plots should be established on a variety of sites because yields from thinnings and rates of growth vary widely with locality. It is recommended that stands on average sites be chosen first, followed by stands on the two extremes of site, so that the final results can be expressed in terms of good, average, and poor sites.

Inasmuch as two degrees of thinning for two methods on three sites plus the accretion on three sites will require 15 plots, not including checks, for a single age class, it is obvious that each method and degree listed cannot readily be begun at once. The first objective should be an adequate test of what seem to be more favorable methods, followed later by the other methods. It is therefore recommended that the French method be given first consideration, but that the accretion thinning be deferred until thinnings have been established in younger stands. Four repetitions representing a

[2] (a) W. W. Ashe. Shortleaf Pine in Virginia. Department of Agriculture and Immigration of Virginia, 1913, p. 17.

(b) W. W. Ashe. Loblolly or North Carolina Pine. North Carolina Geological and Economic Survey Bulletin No. 24, 1915, p. 161.

single age and site class for each method and degree of thinning should constitute the minimum number of plots necessary for sufficiently reliable results. The check plot should be duplicated if time and funds are available. One replication should be sufficient.

Collection of Field Data

Plots should be established in stands which are:

a. Even-aged (with the oldest and youngest trees differing in age by not more than five years).

b. Normal (producing wood at the fullest capacity for that species, age, climate, and soil).

c. Pure (with 80 per cent or more of the trees of a single species).

It is of primary importance to obtain data from pure stands of the younger age classes so that observations can be continued through an entire rotation. Young stands should be classified according to age as follows:

Age class	Range in age
10-year	8-12 years
15-year	13-17 years
20-year	18-22 years
25-year	23-27 years

Later it may be desirable to establish plots in stands which range from 25 to 35 years of age, as well as in mixed stands.

Thinnings in mixed stands are more complicated because the dominant canopy rarely contains an equal number of both species. In such cases the species which gives the most promise should be favored. However, if stands are encountered in which both species have approximately equal representation in the dominant canopy, a careful determination of the site for each species will give an indication of which species should be favored. Thus, in a fully stocked stand 20 years of age in which the two species occur in equal mixture, if the site determinations show an index of 80 for shortleaf and 90 for loblolly, the loblolly should be favored. Reference to the normal yield tables indicates that at 40 years of age shortleaf on that site will yield less than will loblolly. However, if the site index should be the same for both species (assume it to be 90), the shortleaf should be favored because the yield tables indicate that shortleaf on that site will give a higher yield than will loblolly at 40 years of age.

This procedure should be modified if shortleaf trees occur in pure stands of loblolly pine. The site determination for the shortleaf trees may not be reliable because the trees have been subjected at an early age to competition with a species which develops more rapidly during the first 10 years than does shortleaf. Such a condition might retard growth, and hence affect the site index. Furthermore there is evidence that the shortleaf trees which survive such competition respond better to thinning than the loblolly trees among which they stand. This may be due to the fact that such trees are inherently superior trees which, if favored, may eventually exceed the average loblolly tree in development. Certainly, they are the best of the shortleaf trees. It might be well to favor such trees not only for the purpose of obtaining a greater yield but for genetical reasons also. The seed of such trees might be of better quality, and the average offspring might be superior to the average offspring of a pure stand of shortleaf. At any rate, a study of the quality and amount of seed produced by such trees

might well be made. For this reason it is suggested that shortleaf trees be favored if they are of the proper size and condition.

The plots may be selected and laid out in any season of the year, but, in the States served by the Southern Forest Experiment Station (Georgia and Florida to Oklahoma and Texas), all other work should be done during the non-vegetative season because the cool weather of the winter months makes for better working conditions and retards the activities of destructive insects which are attracted by freshly cut timber during the growing season (March to October).

The successive steps necessary for the proper establishment of thinning plots are given below. The steps outlined for actual measurement of the stand will also serve for the periodic remeasurements.

1. Locate even-aged stands which appear to be normal and extensive enough for the establishment of at least three plots, one to be thinned lightly, one heavily, and one left unthinned as a check. Plots should not be smaller than 0.2 acre, and need not be larger than 0.5 to 0.75. Plots smaller than 0.2 acre may constitute a fair sample in young stands, but as the timber grows older the accuracy from such a small-sized sample decreases.

Plots may be square, rectangular, quadrilateral, or circular. Quadrilateral plots should have no angles of less than 60°; circular plots should not be used on decided slopes unless a range finder is available. Quadrilateral plots are the most flexible; circular plots are the most convenient and economical. In addition circular plots have a perimeter which is more than 10 per cent shorter than the perimeter of a square plot of equal size; hence it is unlikely that there will be as many line trees on a circular plot as on square or rectangular plots.

2. Allow for a neutral or isolation strip of at least 40 feet between and around the plots, if this is at all possible.

3. Determine the site of each stand by taking increment cores and heights from at least 10 dominant and codominant trees scattered throughout the stand. Record the data in the proper spaces on the standard form.[3] Increment borings should be taken at a one-foot stump height. The total age is then determined by adding two years to the core count. If borings are made at breast height add three years to core count (for loblolly and shortleaf pines).

Grouping two or three adjacent plots into a single series may result in inequalities of sites; for example, one of the plots may be located near the bottom of a slope where the soil may be more productive than that on the other plots. Such a plot is odd in the sense that it is not comparable with the other plots in the series. Although in most cases the differences in site are not great, occasionally a range of 10 to 15 feet in site index will be found in plots of the same series. Such a series cannot be considered a complete test. Inspection of the data on the other plots in the vicinity may show a plot or series in which the age and site are comparable with that of the odd plot. These may then be treated as a comparable series although located a considerable distance apart, provided other conditions are similar.

[3] Copies of this form will be supplied to any one interested on request to the Director, Southern Forest Experiment Station, Custom House, New Orleans, La.

If the age of the stand and the site meet the requirements, temporary plots should be staked out, keeping a record of the bearing and length of each line. If a plot record is taken and it is later found that the plot cannot be used because it is not comparable with other plots but may become so several years hence, the records and plot location should be kept for possible future use. If the stand is not of the age and site conditions desired, plots should not be laid out but a permanent record of the site, age, and general location should be kept because it may serve some other purpose, such as a study of the development of understocked stands.

The various plots should be located with reference to each other by recording the bearing and distance between the two nearest corners. Also, at least one corner of one plot in each series should be located with reference to a land office corner, preferably to a section or lot corner, or otherwise to a well-defined landmark, such as the chimney of a nearby house, a bridge, a road junction, etc. A sketch map of the plots and immediate vicinity should be made while in the field. This can best be done with a protractor on cross-section paper. Each map should be accompanied by directions for reaching the plot from the nearest town. A motor log has proved very convenient for this purpose. All maps should be labeled with the project designation and the plot numbers. Stakes should preferably be of iron; they should be painted white with the plot number in black on stake number one, which marks the beginning of the plot survey. All of the work up to this point may be done in the summer months, but the final location need not be determined until the utility of the plots for experimental thinning is assured.

5. A rapid D. B. H. tally by species and crown classes should follow step 4. Calipers should be used for this work, and the trees recorded by inch classes. From this tally the basal area per acre of the plot can be computed and compared with normal yield table figures for stands of the same age and site. The deviations allowed for individual plots from the yield table values are readily ascertainable from the average deviations as shown in the second-growth southern pine yield tables. If the deviation of the plot basal area per acre falls within the allowable range the plot can be accepted as normal. Plots in which the deviation comes very close to the limits of the normal deviation should be used only where absolutely necessary to get the required number of plots in one age and site class.

After the normality test has been made, each plot should be subjected to a simple statistical examination in order to determine its comparability to any other plot in a stand of the same age and same site index, on the basis of mean diameter and coefficient of variability. The D. B. H. tally sheets represent a frequency distribution so that such a statistical analysis can readily be made. This analysis should always be made because it will give definite information regarding the comparability of several plots in stands of the same age and site index, and thus make it possible to determine which plots should be included in a certain experiment. This cannot always be determined by the normality figure, or by a comparison of the basal areas.

In comparing any two plots the mean, the coefficient of variability, and their probable errors are first obtained for each plot by the usual methods. The differences between the two means and the two coefficients of variability, with their probable errors, are then determined and compared. If the difference divided by the probable error of the difference is 3.0 or less, it is not significant, and it is safe to assume that the stands are comparable on the basis of mean diameter and distribution of diameters around the mean diameter. If the value is greater than 3.0, either for the mean or the coefficient of variability, the difference is significant and indicates that the stands are not comparable and should not be used in the same test.

Diameter, class, inches	Plot 80 No. of trees	Plot 81 No. of trees
2	17	15
3	51	60
4	50	46
5	38	38
6	32	28
7	15	21
8	10	10
9	6	1
10	..	1
	229	220

Plot	Mean, inches	Coefficient of variability Per cent
80	4.707 ± .0775	37.28 ± 1.175
81	4.536 ± .0755	36.90 ± 1.186
Difference (D)	.171	.38
Probable Error of Difference (P. E. D.)	± .108	± 1.66
D ÷ P. E. D.	1.5	.22

The above example indicates the way in which the analysis works in the case of two specific plots.

Since the difference divided by the probable error of the difference is less than 3.0 both for the mean and the coefficient of variability, the two plots may be regarded as comparable.

6. The next step is to mark the plots for thinning. While marking the first few plots, temporary blazes with white chalk can be used to designate trees to be removed. The Swedish system of marking by striking the tree with a bag of dry paint has been tried and found very convenient. A good quality waterproof paint known as "Powderpaint" is now being tested on a number of plots. It is convenient because it may be carried as a powder, and when mixed with water can be used for permanent marking. After the preliminary marking with dry paint is completed, the final blazing can be done with an axe or timber scribe, a careful revision of the earlier marking taking place at the same time. Opposite sides of each marked tree should be blazed and numbered with keel or indelible pencil near but never at the breast height point. This would not be necessary in a commercial operation, where a blaze on one side would be sufficient. In experimental thinnings some loss of time may be avoided by marking each tree on opposite sides, as

some trees will fall with the number down and difficulty will be encountered in finding the number if only one side is numbered. The blazes should face in the same direction; that is, each tree should be blazed on the north and south side or on the east and west. This enables one to readily locate particular trees.

Thinning should not be confined strictly to the plot, but should extend from 15 to 25 feet outside its boundaries to insure that the trees near the edges of the plot receive the same effect from the thinning as do those inside. This means that in adjoining plots the type of thinning in each plot will extend approximately half way across the neutral strip. The width of this outside strip will vary with age, the wider strip being used in stands 35 to 40 years old.

As suggested by Righter,[4] the check plot also should be marked at the same time and in the same degree as the thinned plot, but with painted blazes only. This will designate that stand on the unthinned plot which is comparable to the residual stand on the thinned plot; it will also indicate the stand on the unthinned plot which is comparable to the stand to be removed on the thinned plot. By this method the growth on the theoretical residual stand on the check plot can be compared at any time in the future with the growth on the actual residual stand on the thinned plot. The investigator may determine at any time in the future the importance of the rôle played by the stand on the check plot which is marked for a theoretical cutting. Incidentally, it will be possible to demonstrate for a number of years just what was done on the thinned plot. The mere inspection of a plot following a thinning gives a very inadequate impression of the trees which were removed in the thinning; by the method just described, a much better impression may be obtained.

If both a light and a heavy thinning are to be included in the experiment the check plot should be marked for both. The additional trees to be marked in the theoretical heavy thinning can be blazed with paint of a different color, or one set of blazes can be placed above the tree number and the other set below. If two degrees of thinning are to be included in the experiment, that stand on the lightly thinned plot which corresponds to the residual stand on the heavily thinned plot should be designated by painted blazes.

Letting

O = Residual stand on heavily thinned plot and corresponding stands on the check and lightly thinned plot;

X = Trees on check and lightly thinned plot which would have been removed in a heavy thinning;

X′ = Trees on check plot which would have been removed in light or heavy thinning,

it is possible to make the following comparisons:

Tests

Heavy O versus Light O
Heavy O versus Check O
Heavy O versus Light O and X
Heavy O versus Check O and X
Heavy O versus Check O and X and X′
Light X versus Check X
Light X and O versus Check X and O
Light X and O versus Check X and O and X′

[4] F. I. Righter. A More Scientific Method of Experimental Thinnings. Journal of Forestry, March, 1929.

In addition, the importance of the rôle played by the stands represented by the X and by the X and X′ trees in the development of the total stand can be determined by measurements on the check plot at any time in the future. These measurements will yield exact information about the percentage of the total volume increase which is accounted for by the stand in question.

8. Before any thinning is done a complete tally by D.B.H. and crown class should be made for the trees to be cut. Each tree measured should be assigned a permanent number for future reference, and the measurements should be recorded on the standard permanent record form. Data on form point should also be obtained at this time and recorded separately. Measurements should preferably be made during the winter season when trees are dormant. Diameter tapes should be used for all diameter measurements and these measurements should be taken to the nearest tenth of an inch. The practicability of using a basal area tape should be investigated because the use of such a tape would eliminate the office computation of basal areas from the recorded diameters without increasing appreciably the field work required. Certain changes in the Permanent Sample Plot Enumeration sheet would be required if the basal area tape should be adopted; such changes would limit the amount but not change the character of the data which may be accommodated on a single sheet, and it is probable that considerable time would thereby be saved.

The forest service standard hypsometer should be used for taking heights to the nearest foot. There has been considerable criticism of this instrument, but a test made on 50 trees showed that when carefully used the average heights taken by the standard hypsometer were within one foot of the actual measured average height of the trees when felled.[5]

9. Cutting of trees marked for removal should follow soon after their measurements are completed. The fallers should endeavor to fell the trees so that they will scrape along the boles of the trees to be left, thus breaking off dead limbs which, if left, tend to lower the quality of lumber produced in the final stand.

10. If a study of form and a volume table check of individual trees are to be made, the stem measurements should be taken at this time. The heights should be measured with a tape to the nearest tenth of a foot. Stem data including diameter inside and outside of bark at intervals along the stem should be obtained and plotted, in the field, on U. S. Forest Service form 558A. Stem analyses should also be made and, if local volume tables are to be constructed, any additional data which may be required should be gathered at this time. In gathering the data specified, some trees in each inch diameter class must be obtained. Sufficient tree lengths must be taken to make possible the construction of a separate height curve for the felled stand so that the volume of that stand can be computed separately. If the stand should consist of more than one species, sufficient height and diameter measurements should be taken to construct reliable height-diameter curves for each species. The number of measurements needed for a good curve can be determined by plot-

[5] L. I. Barrett. Accuracy of Forest Service Standard Hypsometer. Journal of Forestry, May, 1929.

ting the data, in the field, on the space provided on the standard form. Experience indicates that at least 25 tree heights for the removed stand will be necessary for each plot.

11. All merchantable cordwood should be piled on or near the plot, measured, and the amount recorded on the standard form. The bolts should be piled against stakes driven in the ground, and never against living trees, in order to safeguard against insects. Although there is some variation throughout the South in size of cordwood which is considered merchantable, care should be taken to use the limits of utilization given in the second-growth southern pine cordwood tables. This means cutting to a one-foot stump and to a three-inch top, inside bark. The actual measurements of the piled wood will serve as a valuable check on the volume tables.

Other information such as the time required for marking and thinning should be taken and recorded in the space provided on the standard form. Brush may be piled or removed from the plot or left as it falls. However, lopping should be avoided as this retards drying out of the wood and prolongs the period during which the cut stems are attractive to destructive insects.

12. When the actual thinning work has been completed, notes on the residual stand should be taken. The trees should first be numbered. It is recommended that this be done by smoothing the bark at a point 5 or 6 feet above the ground and putting the numbers on with white paint. Figures 3 inches high have proven to be practicable. Only a high quality "outside" paint should be used, and it should be heavy enough to prevent running of the figures. A white dot, an inch in diameter, should be placed at the exact breast-height point on each tree. The bark should never be smoothed off at breast height as this will seriously interfere with obtaining accurate measurements. The trees should be numbered in such a way that each successive number will be visible from the last one preceding.

A tally of the residual stand by D. B. H. and crown class should then be made and recorded on separate sheets. The standard form is arranged so that the data can be placed directly on punch cards for sorting and computing. For information that cannot be expressed by actual numbers coding is necessary. The codes for tree classification and species are given at the bottom of each tally sheet. In the case of the trees removed, the code figure "7" should be placed in the "T. C." (tree class) column of the next period. The spaces reserved for this tree at subsequent remeasurements will thus remain blank, the code figure "7" indicating that the tree had been cut at the previous date. In check plots where trees are marked but not actually cut, the figure "7" should be placed in one of the two extra columns at the extreme right of the standard form to indicate which trees would have been removed had the check plot actually been thinned.

The reason for taking some of the measurements after the thinning has been done is that it makes for greater ease and accuracy. In unthinned stands the crowns are often so close together that tops are obscured and considerable time is taken in getting heights. Thinning opens up the stand and heights on residual trees are easily obtained.

13. Sufficient heights should be obtained on the residual stand so that average heights for each D. B. H. inch class will be available for the purposes of volume computation.

14. After all work on the plots has been finished the trees marked for thinning on the isolation strip should be felled. These need not be cut into bolts nor removed from where they fall unless they are a menace to the remaining stand.

15. Each plot should be photographed from each plot corner, before and after thinning. If circular plots are used the photographs should be taken from the four cardinal points of the compass looking into the plot, or from the center in four directions, looking out.

16. A physical description of the plot should be made at this time on the proper form. Soil samples may be taken for physical and chemical analysis. The previous history of the area should also be ascertained by interviewing people who are intimately acquainted with the district. This history should include facts of ownership, logging history, cultivation, fire damage, grazing history, etc.

Organization of Field Work

A three-man party forms the most effective crew for the establishment of thinning plots, and two are absolutely necessary. It is often possible for coöperating agencies to furnish the labor for the actual thinning. Work done by local labor will also give more representative cost figures than when the technical crew is used.

The field work for a party of three may be organized as follows:

1. Locate a number of prospective stands.
2. Determine site:
   - 1 man record data;
   - 1 man take increment borings and hold chain;
   - 1 man measure heights.
3. Stake out plots:
   - 1 man compass;
   - 2 men chain.
4. Tally trees by species, crown, and diameter class:
   - 2 men caliper;
   - 1 man tally.
5. Determine comparability of plots on basis of basal area. This may be done in the field or in the office, depending on circumstances, and all three men can help.
6. Mark for thinning:
   - 1 man caliper;
   - 1 man mark;
   - 1 man number.
7. Tally marked stand by diameter and crown class:
   - 1 man take diameters with tape;
   - 1 man tally;
   - 1 man get form points.
8. Cut marked stand;
   - 1 man notch;
   - 2 men fell trees.
9. Stem studies:
   - (A) 1 man mark bolts;
     2 men measure lengths.
   - (B) 1 man measure D. O. B.;
     1 man measure D. I. B.;
     1 man plot on U. S. Forest Service form 558A.
10. Buck up trees into bolts (pulpwood size);
    - 2 men saw or chop;
    - 1 man make stem analyses and then pile bolts.
11. Number residual stand:
    - 1 man scrape;
    - 2 men paint.

12. Tally residual stand by diameter and crown class:
    2 men measure;
    1 man tally.
13. Measure height on residual stand:
    1 man use hypsometer;
    1 man chain and record;
    1 man figure form points.
14. Cut marked stand on isolation strip:
    1 man notch;
    2 men fell.

EQUIPMENT NEEDED

1 150 or 200 ft. steel tape
1 increment borer
1 aluminum tally board
1 Forest Service hypsometer
1 Forest Service compass and staff
2 calipers (24-inch arm)
2 diameter tapes (10 foot)
1 set of volume tables for southern pines (includes basal area table)
1 scale (rule divided into 10 equal spaces) for obtaining form points
1 cross-cut saw (6 foot)
1 double-bitted axe; 1 pole axe
1 machete or brush hook
1 Swedish bark-measuring instrument
Powder paint, approximately 1 pound for 500 trees
2 small paint brushes, ¼" diameter, stiff bristle
1 large paint brush, 2 inches wide, flat (for painting blazes)
1 water jug
1 draw shave
1 soil auger and 6 soil cans
Supply of 558A forms and enumeration sheets, notebooks, slide rule, scale, protractor, pencils, map of region if available
Surveyor's pins (1 dozen)
Camera and films (preferably 5" x 7")
Keel or chalk
1 Timber scribe

PRESENTATION OF RESULTS

In interpreting the results of a thinning study as outlined in the foregoing pages, certain facts should be presented. The results will vary with each method of thinning and each set of conditions, and a comparison of these facts will determine the relative value of the different methods of thinning, and will show what may be expected under various conditions of site and age. The following discussion attempts to indicate the various ways in which these facts may be presented.

1. In order to be of value, growth per cent figures must be based on the volume of the stand after one thinning and the volume immediately before the next thinning. Either periodic annual or total periodic growth per cent can be used; but in cases where the period thinning between varies, the former furnishes the best means of comparison. Growth per cent is not to be considered as the ultimate test of any thinning practice. However, it does furnish a good means of comparison of the thinned stands to the check plots.

A growth per cent figure should be computed not only for the residual stand on thinned plots and the total stand on the check plots, but also for the theoretical residual stands and the theoretically removed stands on the check plot.

Average diameters should be computed from average basal area figures; plot volumes should be computed by the standard method used by the Branch of Research. This consists of computing

an average D. B. H. for each inch class, reading the corresponding average height from the height curves, determining the volume of this average tree from the volume table, and multiplying this volume by the number of trees in the inch class. A total of all inch class volumes will then give the volume of the plot.

2. Rarely have comparative stand tables been used to express the final value of a thinning. Such tables along with total volume production of the various plots furnish one of the best means of presenting the results of a thinning. Tables 1 and 2, showing conditions at the beginning of the experiment and at the end of 10 years, are examples. The volumes given are approximate and are used here for the purpose of illustration. In the future these comparative stand tables should be made for the theoretical residual stand, the theoretically cut stand, and the total stand on the check plot. The theoretical residual stand and the total stand should be compared separately to the stand table for the thinned plots.

Such a table based on 10 to 15 plots for each degree of thinning would doubtless show a much closer comparison of stand conditions at the beginning of the experiment than is true of the example given.

Figures 1 and 2 illustrate a method of graphical presentation of the reaction of a stand to thinning. In the example given, each curve was based on a single plot. In this case the total stand has been used as the basis of comparison, but in a complete analysis the stand might well be treated separately by crown classes, and the reactions thus traced in more detail. There is another graphic method which might furnish a very good means of analyzing the reaction of a stand to thinning. This consists of grouping the trees left after the first thinning into inch classes and tracing the subsequent growth per inch class. This could be done by plotting the D. B. H. increase of each group of trees over the original average D. B. H. of each group. Comparisons should be based on average figures after one thinning and just before the next is made.

Figure 3 presents a hypothetical case as an example. Comparisons between such curves based on the checks and various types of thinning plots will help to give a better picture of the behavior of thinned stands. Similar curves could be constructed based on height instead of D. B. H.

The series of curves just suggested, combined with stand tables, and all based on a large number of plots, should furnish fairly conclusive evidence of the relative merits of the various methods of thinning. In addition to these methods of presentation, which depart somewhat from the conventional methods, there will of necessity be large amounts of tabular data. These tables should show the volume and number of trees per acre, average D. B. H., and average height by crown class and species for the plots, both before and after each thinning. Summary tables showing the same information for the total stand are also desirable. Such tables are more or less common, and, in the past, have often been used to present the final results of thinning tests. They are valuable but, after several thinnings and remeasurements, they become so cumbersome that the significant facts do not stand out. This is especially true where the relative values of several methods of thinning are being investigated.

TABLE 1

STAND OF LOBLOLLY PINE 21 YEARS OLD IN 1915 BEFORE THINNING

D. B. H.	Check plot		Light thinning		Heavy thinning	
	Average height [a]	No. of trees per acre	Average height	No. of trees per acre	Average height	No. of trees per acre
Inches	*Feet*		*Feet*		*Feet*	
3	..	4	..	...	..	...
4	..	72	51	4	50	56
5	..	168	55	80	53	112
6	..	172	58	148	57	160
7	..	160	61	148	60	124
8	..	108	64	84	63	92
9	..	48	66	48	65	40
10	..	16	69	32	66	36
11	..	4	71	12	67	8
Total	..	752	..	556	..	628
Total cords pulpwood per acre		43.0	..	41.1	..	39.1

[a] No heights were taken on this plot in 1915, so heights for volume computations were read from curve for lightly thinned plot.

TABLE 2

STAND OF LOBLOLLY PINE 31 YEARS OLD IN 1925 THINNED IN 1915 AND 1920

D. B. H.	Check plot		Light thinning		Heavy thinning	
	Average height	No. of trees per acre	Average height	No. of trees per acre	Average height	No. of trees per acre
Inches	*Feet*		*Feet*		*Feet*	
4	43	4	..	...	..	...
5	52	20	..	...	..	...
6	60	72	..	...	..	...
7	66	64	70	24	65	4
8	70	80	73	36	69	28
9	72	56	76	60	74	44
10	74	56	79	44	78	36
11	75	24	81	40	81	24
12	75.5	8	83	20	84	20
13	76	4	83.5	8	86	24
14	..	...	84	8	87	...
15	..	...	..	...	88	4
Total	..	388	..	240	..	184
No. of trees 12″ D. B. H. and over		12	..	36	..	48
Vol. bd. ft. per acre Int. ¼″ rule of trees 12″ and over		1560	..	5976	..	8208
Total cords standing in trees 4″-11″ D. B. H.		39.5	..	32.8	..	22.8
Cords cut in thinning......		...	..	18.5	..	24.2
Total cord production.....		39.5	..	51.3	..	47.0

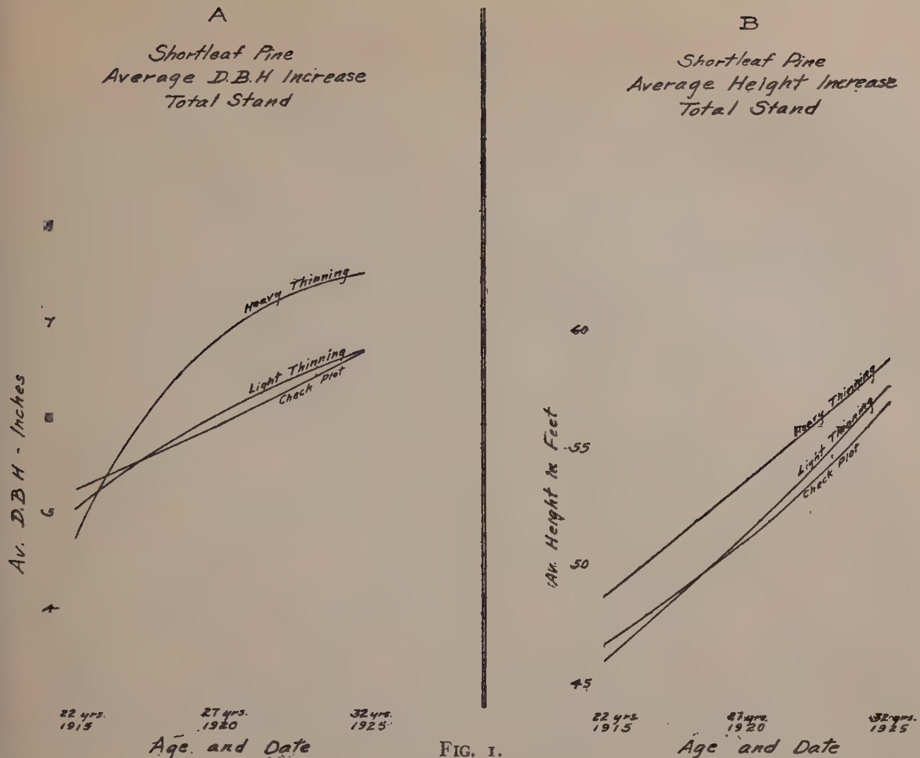
A
Shortleaf Pine
Average D.B.H Increase
Total Stand
Av. D.B.H - Inches
Heavy Thinning
Light Thinning
Check Plot
22 yrs.
1915
27 yrs.
1920
32 yrs.
1925
Age and Date
B
Shortleaf Pine
Average Height Increase
Total Stand
Av. Height in Feet
60
55
50
45
Heavy Thinning
Light Thinning
Check Plot
22 yrs.
1915
27 yrs.
1920
32 yrs.
1925
Age and Date

FIG. 1.

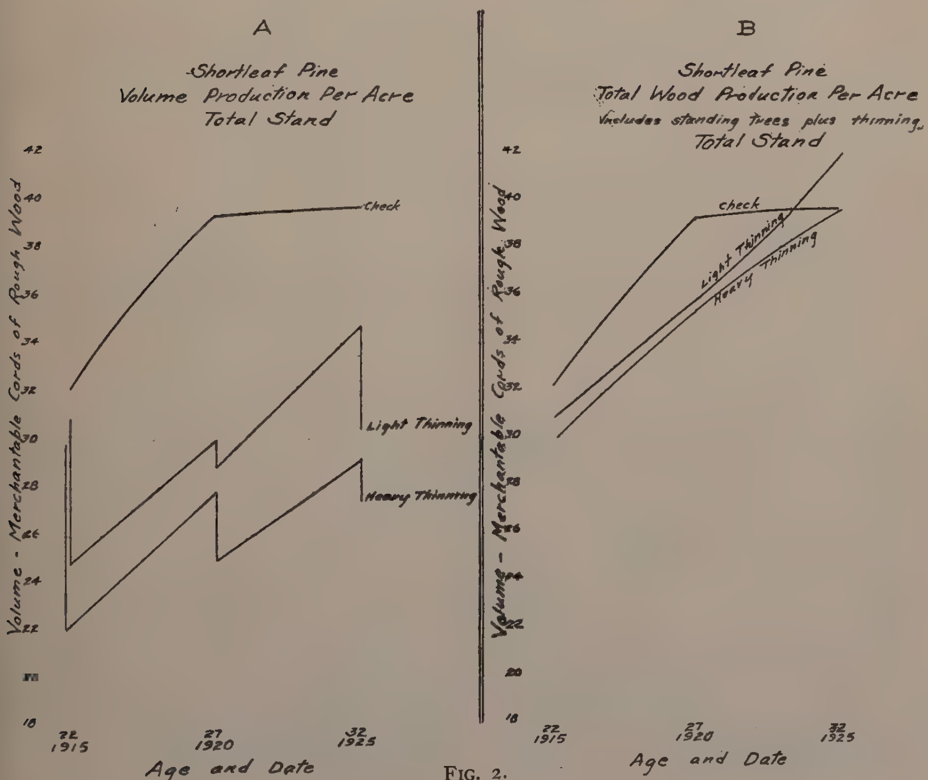
A
Shortleaf Pine
Volume Production Per Acre
Total Stand
Volume - Merchantable Cords of Rough Wood
42
40
38
36
34
32
30
28
26
24
22
18
Check
Light Thinning
Heavy Thinning
22
1915
27
1920
32
1925
Age and Date
B
Shortleaf Pine
Total Wood Production Per Acre
Includes standing trees plus thinning
Total Stand
Volume - Merchantable Cords of Rough Wood
42
40
38
36
34
32
30
28
26
24
22
20
18
Check
Light Thinning
Heavy Thinning
22
1915
27
1920
32
1925
Age and Date

FIG. 2.

It may be too Utopian a dream to suggest the analysis of plots by multiple curvilinear correlation. By using the yield in thinnings as the dependent variable and such factors as age, site, stocking, number of thinning (*i. e.,* first, second, etc.), and present volume as independent variables, an alinement chart might be constructed for each of several types of thinnings. Another set might be developed using increased growth per cent as the dependent variable. However, to carry through such a project would require a great outlay in time, money, and number of plots. Probably enough data can be collected by the methods already described to test the relative merits of the various methods of thinning suggested.

In closing it may be well to state that the methods of presentation are given largely as suggestions made in the light of the best information at hand. It is difficult to offer detailed recommendations for computations which will be made 15 or 20 years hence. The forest officer responsible for analyzing the data must depend upon his own ingenuity and upon the increased efficiency in methods of computation and presentation which will undoubtedly be developed within the next decade.

The main purpose of this working plan is to help clarify the problem and to provide for the collection of sufficient field data so that the results of thinning experiments may be more easily presented and more completely analyzed than has been possible heretofore.

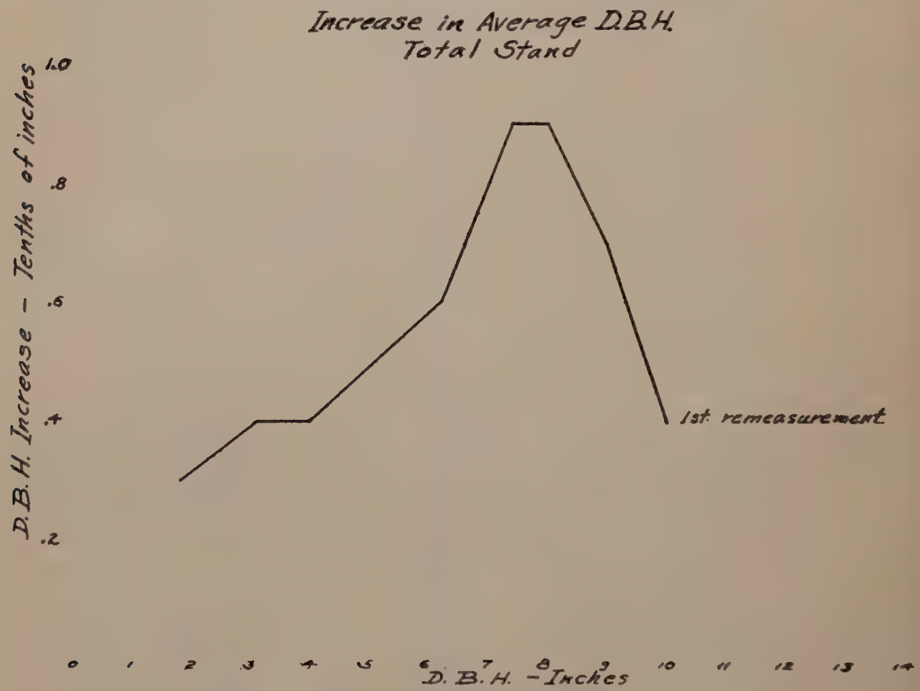

FIG. 3.

Bibliography on Thinning[6]

Akerman, A. Improvement thinning. 14 pp. Boston, Mass., 1905. Massachusetts State Forester. Bulletin 2.

———. Forest thinning. Bulletin 2, Georgia State Board of Forestry, March, 1928.

———. An experiment in thinning loblolly pine. Journal of Forestry, April, 1928.

Archibald, J. C. The effects of over-thinning and ground moisture upon the growth and value of plantations. Quarterly Journal of Forestry, Jan., 1909, pp. 13-19.

Ashe, W. W. Shortleaf pine in Virginia; the increase in its yield by thinning. 44 pp., pl. Richmond, Va., Supt. of Public Printing, 1913.

———. Loblolly or North Carolina pine. North Carolina Geological and Economic Survey Bulletin 24.

Barrett, L. I., and E. W. Gemmer. Progress report on loblolly and shortleaf pine thinning plots at Urania, La. Southern Forest Experiment Station. Unpublished. Oct., 1927.

B. B. Die durchforstung in gebirgswald. Schweizerische zeitschrift für forstwesen. Bern, Switz., June, 1912, pp. 181-185.

Biolley, H. Éclaircie "par le haut" et éclaircie jardinatoire. Journal forestier suisse, Berne, Oct., 1921, pp. 181-186.

Baker, W. M. Some results of demonstrations of cleaning and thinning in farm woods. Journal of Forestry, Nov., 1923, pp. 693-699.

[6] Originally prepared in 1924 by the Washington office of the U. S. Forest Service. Additions have been made in the present copy in an effort to bring the bibliography up-to-date.

Bogue, E. E. Woodlot thinning. Forestry and Irrigation, Aug., 1906, pp. 385-388.

Bourne, R. A classification of thinnings and increment fallings. Indian Forester, July, 1916, pp. 368-371.

Broilliard, C. De l'éclaircie des epiceas. Revue des eaux et forêts, Jan. 1, 1902, pp. 1-9.

———. De l'éclaircie chez les particuliers. Bulletin de la Société centrale forestière de Belgique, Jan., 1904, pp. 1-14.

———. Des resultats de l'éclaircie. Revue des eaux et forêts, Jan., 1901, pp. 1-10.

Cannon, D. Reflexions sur les éclaircies. Revue des eaux et forêts, 1890, pp. 49-54, 255-258.

Chittenden, A. K. Thinning woodlots. Michigan Agricultural Experiment Station Quarterly Bulletin, Nov., 1922, pp. 83-84.

Clifford, J. D. The effect of thinnings on a young teak plantation. Indian Forester, Jan., 1919, pp. 16-18.

Cook, H. O. How to make improvement thinnings in Massachusetts Woodlands. 21 pp., pl. Boston, State Forester's Office, 1910.

———. Instructions for making improvement thinnings. 35 pp., pl. Boston, State Forester's Office, 1914.

Cope, J. A. Thinnings in loblolly pine at a profit. Journal of Forestry, Nov., 1921, pp. 759-761.

———. Loblolly pine in Maryland, State Department of Forestry, 1925.

Cuif, É. Étude sur deux places de production. Revue des eaux et forêts, Dec. 1-15, 1918, pp. 705-729, 738-745.

Dietrich, Ueber einen durchforstungsvergleichsversuch in fichtenbeständen erster bonität. Allgemeine forst- und jagdzeitung, July-Aug., 1923, pp. 152-163, 169-180.

Die durchforstungen in lichte der neuesten forschungen. Allgemeine forst- und jagdzeitung, Jan., 1905, pp. 28-35.)

Engler, A. Die hochdurchforstung. Mitteilungen der Schweizerischen centralanstalt für das forstliche versuchswesen, 1924, vol. 13, pp. 285-351.

Fatou, P. L'éclaircie française. Revue des eaux et forêts, Oct. 1, 1918, pp. 223-227.

Fernow, B. E. Principles of interlocation. Journal U. S. Assn. of Charcoal Iron Workers, 1882, vol. 2, pp. 344-352.

Fisher, R. T. The yield of volunteer second growth as affected by improvement cutting and early weeding. Journal of Forestry, May, 1918, pp. 493-506.

Flury, P. Einfluss verschiedener durchforstungagrade auf zuwachs und form der fichte und buche. Mitteilungen der Schweizerischen centralanstalt für das forstliche versuchswesen, 1903, pp. 1-246.

Forbes, W. The best method of thinning mixed plantations. Transactions of the Royal English Arboricultural Society, 1893-4, vol. 2, pp. 326-330.

Gleadow, F. and others. Proportionate fellings in selection areas. Indian Forester, 1901, pp. 339-340, 517-519; 1902, pp. 10-11, 218-219.

Graves, Henry S. Principles of handling woodlands. John Wiley & Sons, Inc., 1911.

Hanzlik, E. J. Comparative increase in volume of artificially and naturally thinned stands. Journal of Forestry, Apr., 1924, pp. 386-388.

Hawes, A. F. Economic thinning of white pine. Forestry Quarterly, Dec., 1907, pp. 368-372.

Hawley, Ralph C. A progress report of the results secured in treating pure white pine stands on experimental plot at Keene, New Hampshire. Yale University, School of Forestry, Bull. No. 7, 1922.

———. A second progress report of the results secured in treating pure white stands on experimental plots at Keene, New Hampshire. Yale University, School of Forestry, Bull. No. 20, 1927.

———. The practice of silviculture. John Wiley & Sons, Inc., 1921.

Heck, C. R. Freie durchforstung. 115 pp. Berlin, J. Springer, 1904.

———. Höhenstammzahldurchforstung und freie durchforstung. Forstwissenschaftliches centralblatt, Nov., 1923, pp. 421-427.

Henmann. Zur statik des durchforstungsbetriebs. Allgemeine forst- und jagdzeitung, Sept., 1916, pp. 205-217.

How to thin trees properly. Country Life in America, Mar., 1910, pp. 630-632.

Howard, S. H. A classification of thinnings and increment fellings. Indian Forester, Feb., 1916, pp. 66-71.

Hubbard, W. F. Forest thinning and its results. Forestry and Irrigation, June-July, 1904, pp. 268-271, 313-319.

Illick, J. S. Sandy Ridge improvement cutting. Journal of Forestry, Jan., 1917, pp. 104-105.

India, Forest Dept. Classification of thinnings. 5 pp., pl. Calcutta, 1922. Forest bulletin No. 52.

Jürgens. Lauterungshiebe und jugend-durchforstungen. Allgemeine forst- und jagdzeitung, May, 1915, pp. 116-120.

Judd, C. S. Thinning Algaroba forests. Hawaiian Forester and Agriculturist, Feb., 1921, pp. 32-35.

Kittredge, Joseph, Jr. Thinning red pine. Journal of Forestry, May, 1927.

Kraft, C. Beiträge zur durchforstung- und lichtungsfrage. 71 pp. Hannover, Klingworth's Verlag, 1889.

———. Beiträge zur lehre von den durchforstungen, schlagstellungen und lichtungshieben. 147 pp., pl. Hannover, Klingsworth's Verlag, 1884.

Kubelka, A. Ein durchforstungsversuch in Douglas-tanne. Mitteilungen aus demforstlichen versuchswesen Oesterreichs, 1914, heft 38, pp. 9-34.

Kunze, N. Ueber den einfluss verschiedener durchforstungsgrade auf den wachstunsgang der waldestände. Tharandter forstliches jahrbuch, 1910, pp. 19.43.

Laschke, C. Oekonomik des durchforstungsbetriebes; national-ökonomische studie eines forstmannes. 87 pp. Neudamm, J. Neumann, 1901.

Li, T. T. Do thinnings actually increase growth per acre as compared to unthinned stands? Journal of Forestry, Feb., 1923, pp. 125-128.

Lorey. Unsere durchforstungsversuche. Allgemeine forst- und jagdzeitung, 1901, pp. 1-8, 504, 86-94.

Marshall, H. J. Thinning of plantations. Quarterly Journal of Forestry, Apr., 1910, pp. 139-140.

Mer, E. Influence de la dimension des arbres sur l'efficacité des éclaircies. Revue des eaux et forêts, July-Aug., 1919, pp. 141-146; 165-175.

———. Recherché de la limite optima d'intonaite dans les éclaircies. Revue des aux et forêts, Feb.-Mar., 1917, pp. 33-43, 65-72.

Milani. Beiträge zur durchforstungsfrage. Zeitschrift für forst- und jagdwesen, Nov., 1914, pp. 646-654.

Morrison, H. M. How plantations are thinned. Canadian Forestry Journal, Aug., 1916, pp. 674-677.

Munns, E. N. Working plan, cultural methods in California. Unpublished. U. S. Forest Service, Feb., 1920.

Nossek, C. E. Ein beitrag zur lehre von den durchforstungen. Allgemeine forst- und jagdzeitung, Aug., 1903, pp. 251-260.

Olmsted, F. E. Improvement felling as a financial success. The Forester, Apr., 1901, pp. 85-88.

Patterson, C. B. Clearings, thinnings and improvement fellings. Indian Forester, Apr., 1917, pp. 202-203.

Puster. Die englische durchforstung. Forstwissenschaftliches centralblatt, Mar., 1917, pp. 120-130.

Rave. Ueber durchforstung von laub- und nadelnhölzern. Zeitschrift für forst- und jagdwesen, Nov., 1906, pp. 736-748.

Righter, F. I. A more Scientific Method of Experimental Thinning. Journal of Forestry, March, 1929, pp. 280-281.

Rogers, H. C. Thinning a 10-year-old catalpa grove. Ohio Forester, Wooster, Jan., 1917, pp. 7-9.

Robertson, W. M. The line plot system, its use and application. Journal of Forestry, Feb., 1927, pp. 157.

Schädelin, W. Waldboden, durchforstung, natürliche verjüngung. Schweizerische zeitschrift für forstwesen, Nov.-Dec., 1922, pp. 302-311, 334-342.

Schaeffer, A. De la periodicité des éclaircies. Revue des eaux et forêts, 1891, pp. 278-281.

Schiffel, A. Erziehungshiebe mit bezug auf ertragstafeln. Centralblatt für das gesamte forstwesen, Jan., 1901, pp. 1-15, 52-65.

Schotte, Gunnar, Lärken och dess betydelse för svensk skogshushållning. Meddelanden Från Statens Skogsförsöksanstalt. Häfte 13-14, 1916-1917. Band 11. English Summary, pp. LXIX-LXXI.

Schubert, J. Die hochdurchforstung im laubwalde. Forstwissenschaftliches centralblatt, Sept.-Oct., 1909, pp. 461-474.

———. Umtrieb, durchforstung und reinertrag. Zeitschrift für forst- und jagdwesen, Jan., 1907, pp. 8-21.

Schwappach, A. Wie sind junge fichtenbestände zu durchforsten? Zeitschrift für forst- und jagdwesen. Jan., 1905, pp. 11-30.

———. Ueber die wirkung frühzeitiger starker durchforstungen an fichtenbeständen. Allgemeine forst- und jagdzeitung, Feb., 1924, pp. 79-84.

Smythies, E. A. Thinnings and cleanings. Indian Forester, June, 1916, p. 315-317.

Spaeth, J. N. Notes on release of white pine in Harvard forest, Petersham, Mass. Journal of Forestry, Feb., 1922, pp. 117-121.

Sterrett, W. D. Disengagement cuttings in mixed small sapling stands. Forestry Quarterly, Mar., 1913, pp. 62-63.

Tiemann. Die erziehung der bestände in lockerem kronenschlusse. Fortwissenschaftliches centralblatt, May, 1917, pp. 205-211.

Thinnings. Indian Forester, Nov., 1921, pp. 453-459.

Trevor, C. C., and R. Parnell. Cleanings, improvement fellings and thinnings. Indian Forester, Oct., 1916, pp. 515-517.

Troup, R. S. Memorandum regarding prescriptions for improvement fellings in teak working plans in Burma. Indian Forester, Oct., 1909, pp. 534-593.

Urstadt. Ueber durchforstungsversuche und deren ergebnisse. Forstwissenschaftliches centralblatt, Dec., 1916, pp. 556-564.

Veness, J. C. Improvement cutting on a commercial basis at Petawawa experiment station. Canadian Forestry Magazine, Apr., 1922, pp. 724-725.

Wagner, C. Die wichtigsten aufgaben der durchforstungsversuche. Allgemeine forst- und jagdzeitung, Mar., 1905, pp. 85-89.

Walker, A. H. Thinning of deodar. Indian Forester, Feb., 1922, pp. 78-79.

Walker, H. C. Improvement fellings. Indian Forester, Sept., 1907, pp. 415-421.

Weir, J. R. The influence of thinning on western hemlock and grand fir

infected with *Echinodontium tinctorium.* Journal of Forestry, Jan., 1919, pp. 21-35.

Weise. Ueber durchforstungen. Forstwissenschaftliches centralblatt, Apr., 1902, pp. 180-186.

Wimmenauer. Durchforstungsversuche in buchen- und kiefernbeständen. Allgemeine forst- und jagdzeitung, Mar., 1914, pp. 84-90.

———. Zur statik des durchforstungsbetriebs. Allgmeine forst- und jagdzeitung, Jan., 1904, pp. 18-21.

Woolsley, T. S., Jr. Strip thinnings. Proceedings of the Society of American Foresters, May, 1911, pp. 38-41.

Wyman, Lenthall. Results from sample plots in Southern pine experiments. Journal of Forestry, November, 1922.

THINNINGS IN NATURAL STANDS[1]

By CLIFFORD H. FOSTER

Director, Charles Lathrop Pack Demonstration Forest, New York State College of Forestry

SUPPOSE a forester is employed by a timberland owner in the Northeast and entrusted with the responsibility of growing timber for profit. Let us assume that the forest is well located and typical of average forest conditions and that the owner has a limited amount of working capital. What will be the forester's first move, after he has familiarized himself with his forest?

The chances are that his first temptation will be to plant up the idle land. I would not criticise him for this idea—that is what the average owner would doubtless expect him to do and if there is plenty of money at his disposal he would be entirely justified in laying out a reasonable planting program covering a period of years. However, if he is expected to produce a maximum amount of wood in a short time with a small working capital, I would recommend that he spend the bulk of his efforts upon thinning.

What, then, is the first move in that direction? He must first find or create a market for his thinnings. This is apt to be difficult, as existing markets for thinnings are scarce. There are a few possibilities, however—woodenware factories, turneries, small dimension mills, builders of rustic camps and furniture, pulp mills, posts, poles, fuelwood, etc. Unless these industries exist, or can be attracted to the locality, the forester is apt to be up against it. However, there are few timberland owners who now appreciate the desirability or necessity of thinning, so that if the wide-awake ones go after the existing markets there will be an opportunity for most of them to secure outlet for their products. Here is a big problem and a big field for missionary work for most forest managers, inducing buyers to buy the material from thinnings where this will meet their requirements as well as other materials.

Once a market is found, the next step is to determine what stands shall be thinned. Expediency will doubtless dictate that the stands shall be thinned first, in order of their profitableness, and second, in order of benefit to be expected in growth, in the thinned stand, over the next 5 or 10 years.

Many foresters and timberland owners have acquired the conviction that well-stocked softwood stands, especially of white pine, reach their financial maturity at about 35 years of age. This opinion has been arrived at from the study of compound interest tables and yield tables based on wild stands, also from observation of the presence of dead and dying trees in stands of this age. We find, however, that thinnings which have been made in overstocked white pine stands

[1] Presented at the meeting of the New York Section, Society of American Foresters, Albany, N. Y., January 30, 1929.

indicate a tremendous stimulation of growth—even in old, neglected stands. It is time that foresters began to study more deeply into this question. I am not prepared to say how long proper thinning will postpone financial maturity of a white pine stand, under average conditions, but I am convinced it will postpone it beyond the 50-year mark.

Prolonging the financial maturity of the crop is desirable forest practice, since it materially lessens the risk from fire, blister rust, and other destructive agencies by lessening the percentage of young stands in the forest area. Prolonging the profitable age of growing timber is particularly desirable just now in the East as it will tend to build up a larger timber reserve for the time 30 or 40 years hence when we are expecting a materially reduced lumber output from the Northwest.

To my mind, one of the most destructive logging practices in the country today is the clear cutting of 30 to 35-year old stands of softwoods. These stands are just entering the stage of merchantability. Proper silviculture demands that these stands be thinned; ignorance says that they are big enough to cut off, and ignorance prevails. Broadly speaking, if most timberland owners appreciated the full value of thinning versus clear cutting, they would thin three or four times the area annually which they are now clear-cutting to obtain their required materials, and hold the stands which they are now clear-cutting at 30 or 35 years until they become financially mature.

Getting back to the more technical aspects of thinnings, the best silviculturists are of the opinion that thinning is a matter of personal judgment. There are a number of so-called methods of thinning which should be known to every forester, but there is no one method that should be followed over a large area. When one starts out to mark a stand for thinning, he should have a few very important principles in mind: one, to cut to favor the best trees; two, to maintain a proper density; three, to mark in accordance with the market requirements. These are all matters of personal judgment in which proficiency must be gained by experience and study. It should be recognized by every forester that the marking is a job that should not be entrusted to inexperienced hands. We should not give timberland owners the impression that marking is a simple matter which any one can do well. The marking of a thinning is probably the most important duty of a forester and draws on nearly all the technical knowledge he possesses. Timberland owners should be taught to employ trained foresters of experience to do their marking.

There is another idea that seems fixed in the minds of many foresters, that thinning is only to be considered in stands where the products cut will pay a profit over the cost of operating. To me, this idea is absurd. Thinning is practical in all stands where the money invested will pay a profit on the investment. Very dense pine stands of 20 years, if untreated, seldom can promise material for profitable thinning at 30 years. If these same stands were thinned at 20 years, however, they might easily be expected to provide a profitable thinning 10 years later.

Last winter we thinned on the Pack Forest a 45-year-old white pine stand, removing 13 cords per acre from an original volume of 48 cords per acre

with a net profit of $52 per acre. The 35 cords which are left consist of the best trees, in the best growing condition. The average person would probably pay as much for the stand now as before the thinning. The psychological effect or removing the poorer and smaller trees makes the good trees stand out. Many would guess that there is more value on a thinned stand than in the same stand before thinning. As a matter of fact, the value being reduced from $192 to $140 per acre, without impairing the growing capacity of the area, actually makes it a better growing investment. The growth of the next 10 years will now all go on the best trees where it will be worth more per cord than if spread more thinly over twice as many trees. Logging costs per cord will be reduced by having the volume on fewer and larger trees. We also expect that the market value of pine will increase the next 10 years. Therefore we are convinced that thinning is good business, viewed from a number of different angles, and we hope thereby to build up our stock of timber and increase our annual increment with the least amount of working capital.

It is unfortunate that we have so few examples of thinnings to point to as object lessons to timberland owners. Practically all foresters believe in the policy of thinning but few have done very much of it. Practically all the examples of thinning which I have seen could be classed as clearly successful. Some were too light and some were too heavy, but in general the results have been decidedly good.

Foresters should devote more of their efforts to the making of thinnings. On the whole we have talked planting to excess and failed to give proper emphasis to the improvement of natural stands.

How can we expect timberland owners to take proper care of plantations if we fail to point out the necessity of taking proper care of their good natural stands? In many cases these natural stands may be better—even though they did not cost as much. It is the private opinion of many foresters that thinnings, release cuttings, and cleanings are more profitable from a business standpoint than planting. If this opinion is correct, why should we conceal it when expressing our opinion to the public? Foresters as citizens should not be satisfied to accept planting as the only legitimate excuse for spending the public's money in forestry. Why the foresters of the Northeast should show so much interest in the submarginal agricultural land and so little interest in the improvement of the woods is difficult to understand. Surely it is evident that we must increase the growth per acre on the naturally forested areas if we ever expect to have an adequate and permanent local supply of timber.

THE OTHER SIDE OF THE LIGHT QUESTION [1]

By G. A. PEARSON

Director, Southwestern Forest Experiment Station

SINCE FRICKE (4) demonstrated in 1904 that pine seedlings would grow under a forest canopy when the competing roots of the old trees were cut, it has become a fad among forest investigators to prove that light is a negligible factor in forest reproduction. Several modes of attack have been employed. One has been to test seedlings for photosynthesis in different light intensities down to less than 1 per cent of full sunlight. Another has been to grow seedlings several months in different light intensities in order to determine the lowest intensity in which they will survive. Still another has been essentially to duplicate Fricke's experiment in which plants under a tree canopy were freed of root competition by surrounding them with a deep trench.

Most of the experiments tend to show that tree seedlings will live in very weak light. Some investigators have rightly used these findings to point out that other factors than light should be considered as possibilities in limiting natural reproduction in the forest; others go so far as practically to exclude light as a limiting factor. If one may judge by the literature of recent years, the antis are decidedly in the majority. Nevertheless, there are many foresters and ecologists who are not convinced. Before definitely throwing light into the discard, it is well to examine the evidence which has been arrayed against it.

Tests for photosynthesis undoubtedly show that this process may go on in very diffuse light. But the experiments, as far as the writer has been able to learn, pay little attention to the rate of photosynthesis or the rate of growth. A plant does not live by photosynthesis alone. Those foresters who have not entirely forgotten their plant physiology will recall that there is another process called respiration. Respiration represents conversion of the products of photosynthesis into energy by oxidation. Neither photosynthesis nor respiration is active in low temperature. Tests for photosynthesis in low intensities of light are usually made under optimum temperature conditions. What would be the effect if the temperature were at a minimum? Both photosynthesis and respiration would come almost to a standstill. A plant might live a long time under these conditions but it must eventually succumb. Exposure of the plant to strong sunlight would in a measure make up for the deficiency of heat due to low air temperature.

The results of experiments on the relative temperature of leaves in the shade and in the sun are not wholly consistent because of the cooling effect of transpiration, but in low temperatures at least

[1] This article was received for publication prior to the appearance of H. L. Shirley's article, "Light Requirements and Silvicultural Practice," in the May, 1929, issue of the JOURNAL OF FORESTRY, and was prepared without knowledge of Shirley's investigations.

the sun leaves are generally several degrees warmer than the shade leaves. It is also pointed out by Ehlers (3) that the temperature of the leaf as a whole is probably considerably lower than that of the chloroplast. Matthaei (6) found evidence of photosynthesis in a species of Prunus in air temperatures as low as $-6°$ C. when exposed to direct sunlight, and suggests that in conifers under strong insolation photosynthesis may take place in still lower temperatures. It has been stated by foresters that trees growing in cold climates require more light than the same species in warm climates. As pointed out by Toumey (8) the additional light required in the cold climates evidently is nothing more than the heating effect of sunlight.

Anyone who has tried to grow plants under glass has observed that certain species tend to become so slender that the stems will scarcely support the weight of the leaves. This condition is generally attributed to a deficiency in ultraviolet rays. The short wave lengths are said to retard the rate of growth of stems. Some writers seem to regard this effect as wholly harmful, but Wiesner (10) points out that it is necessary in order to develop normal form. It is especially important in forest trees which must have boles and branches capable of supporting great weight. Rank growth of tree seedlings in shade is often mistaken for an exceptionally vigorous condition when in reality the seedlings are abnormal because of the absence of the stabilizing effect of the rays of the short wave length. The writer's experience indicates that this influence may be of greater importance than photosynthesis. Those who criticize the Clements photometer because it is sensitive only to the rays of short wave length would do well to bear this in mind.

Long before reaching this point in the discussion some readers will have asked, "What has all this to do with light?" Light, according to the text books, is that agent which by its action upon the retina of the eye produces the sensation of vision. The writer will be accused of confusing light with heat and including under light portions of the solar spectrum which are invisible to the human eye. In reply he ventures to ask, "What relation is there between the human eye and the requirements of plants?"

There is every reason to believe that the old-time foresters in speaking of light had no intention of confining it to the technical definition given by physicists. It is doubtful whether many of them had seen a solor spectrum or had even heard of wave lengths. But they had observed that light in the broad sense, meaning sunlight or solar radiation, and including heat, illumination, chemical activity, and other effects, exerted a strong influence upon plant life. They may have gone too far in attributing to deficient radiation unfavorable conditions due to deficient soil moisture, but there is plenty of evidence that soil moisture and root competition were not ignored.

Experiments such as those carried on by Bates and Roeser (1) and Grasovsky (5), in which the development of seedlings in different light intensities was observed over a period of several months, should give good information if followed up for 5 or 10 years, and if tried in low as well as in relatively high temperatures. Conducted as they were under favorable heat conditions, they merely show that under these conditions low light intensities suffice for photosynthe-

sis. Whether photosynthesis was sufficiently active to promote effective growth and whether there was enough radiation of short wave length to develop normal form over a period of years is not considered. In fact Bates and Roeser's data show that the weight increment rises consistently with light intensity up to the highest used, which was about 11 per cent.

What will impress foresters most is the trenching experiments by Fricke (4), Toumey (9), and others. In these experiments it was found that under stands where natural reproduction was poor or lacking, the isolation of plots by cutting the roots of older trees brought a quick response in growth of the seedlings thus freed of root competition. Toumey's experiments showed appreciably higher available moisture content in the trenched plots, although the content for the untrenched plots does not appear dangerously low. It is to be expected that trenching would increase the amount of moisture and that this would stimulate height growth; but whether such species as white pine will show normal development, considering form as well as height growth, after a period of 10 years is less certain. It is to be hoped that Toumey will continue his experiments long enough to make sure of this point. It would also be well to ascertain in what degree the air temperature meets the heat requirements of the species concerned.

During the past six years the writer has had under observation two trenched plots in the western yellow pine forest of northern Arizona. The stand has the typical group formation characteristic of western yellow pine on the Colorado Plateau. Under protection against fire and grazing since 1912, the openings between groups, except for a well-defined space around the trees, have become well stocked with seedlings originating in 1914, 1917, and 1919. Germination was even more abundant in the present blank spaces around the trees than elsewhere, but the seedlings either died or became unthrifty during the first four or five years. The fact that reproduction usually becomes established closer to the trees on the south than on the north side suggests that light is the dominant factor; but the fact that even on the south side the blank space usually extends several feet outside the crowns indicates that root competition is also a factor.

The plots were located on the north side of tree groups, within a zone where considerable numbers of seedlings persisted in an unthrifty condition. These plots receive direct sunlight from one-third to one-half of the day, being shaded through most of the noon period. About 20 feet to the north of the plots, still somewhat shaded, were small but fairly thrifty groups of seedlings from four to nine years old. On the south side of the tree groups, thrifty seedlings of the same age classes occurred in dense masses.

A trench 18 inches deep was dug clear around each plot. Investigations have shown that although the tap roots of seedlings penetrate deeper, a strong system of laterals which constitute the main feeders lies mainly within the surface foot of soil. This rather shallow root habit is attributed to the fact that the soil contains a large proportion of clay, and a hard though not impervious layer is encountered at about 18 inches. The trench was refilled and has since been opened at intervals of one or two years

in order to cut any tree roots which may have invaded the plots.

By 1925, large numbers of the seedlings had died and the survivors had made but little improvement in appearance or rate of growth. At this time each individual seedling was tagged and measured. In 1928, only 10 of the 26 recorded in 1925 were still living. The height growth during 1928 varied from 0.4 to 3 inches, and the total height at that time ranged from 2 to 13 inches, with the exception of one 14-year-old plant which measured 26 inches. Surviving seedlings in near-by shaded but untrenched situations have made about the same growth and are similar in appearance to those within the trenched plots. Seedlings of the same age classes in nearby openings are from 2 to 4 feet tall, and the growth in 1928 was generally between 3 and 6 inches. They have a much more thrifty appearance and are for the most part so dense that competition between individuals must be keen. The contrast is so striking that one glance is sufficient to satisfy anyone that the seedlings within the trenched plots have not made anything like the response reported by Toumey and Fricke. Yet some of the seedlings have actually grown and may persist many years. They have probably benefited slightly from the trenching, but they are not making the growth exhibited by seedlings in openings, which are undoubtedly subjected to considerable competition from the roots of old trees, besides competing among themselves.

The results are not surprising when other circumstances are considered. In digging the trenches, the tree roots encountered were mostly over a half-inch in diameter, and the numerous fine roots which indicate an intensive feeding zone were not much in evidence. Soil samples in similar situations at the height of the dry season in 1920, showed in most cases more moisture at depths of 6 and 12 inches directly under tree groups than in openings 40 to 50 feet from the trees, even where no reproduction occurred in the openings (7, p. 65). Roots are found practically everywhere in openings within 50 to 75 feet from the surrounding trees. Tree roots are probably less numerous at such distances than near the trees, but herbaceous vegetation and direct evaporation due to the absence of shade tend to offset this difference in the upper soil strata.

Contrary to the findings of Craib (2) in New Hampshire, the available soil moisture during the dry period of May and June is nearly always less in the upper foot than at lower depths. This relation is explained by the fact that very little rain falls in Arizona during these months, evaporation is high, and the roots of trees and herbaceous vegetation are most numerous in the upper foot. In the last half of June the soil moisture at levels above a foot commonly falls almost or quite to the wilting point; herbaceous vegetation, including perennial grasses, turns brown and it is only because some roots penetrate well below a foot that trees are able to continue growth. During this period young seedlings in openings bearing dense herbaceous vegetation suffer more from drought than do seedlings of the same age in the shade of trees.

A more pronounced contrast between sun and shade is found in soil temperature than in soil moisture. In summer, at a depth of 1 foot, the soil is usually from 10° to 15° F. warmer in sunny

than in shaded situations. That deficient heat may be a limiting factor is suggested by the fact that the soil temperature on shaded spots in the vicinity of these plots is almost identical with that in open situations at the extreme upper limit of the western yellow pine type. The soil temperature itself may not be a limiting factor, although it probably has considerable influence upon the activity of soil organism. Soil temperature, however, is a good index of the amount of solar radiation which reaches the ground and the leaves. The amount of heat energy available in shaded situations in the upper half of the western yellow pine type in this region is deficient for western yellow pine, and it is in supplying this deficiency rather than in supplying the energy directly concerned in photosynthesis that sunshine is effective.

The purpose in citing these observations is not to contravert the root-competition theory, but merely to point out that it does not hold under all conditions. If a trenching test were made in the lower edge of the western yellow pine type, where temperatures are more favorable, it would probably give better results than those here recorded. But perhaps 80 per cent of the western yellow pine in the Southwest occurs in a zone which is too cold for the best development of this species. The same statement would be true, with minor modification, of Douglas fir and Engelmann spruce. Nor is this relation limited to the southwestern United States. Every species encounters a temperature limit somewhere, be it due to altitude or to latitude.

In the writer's opinion, those who are seeking to belittle the influence of light in the forest are making several mistakes. First, they begin with the questionable premise that foresters generally are inclined to minimize the importance of root competition and soil moisture. Second, in adhering to the technical definition of light which considers only the illuminating effect and ignores the heating and so-called "actinic" effects, they are dealing with artificial conditions which exist only in the laboratory. As far as the forester is concerned, light is solar radiation just as it occurs in nature. Its influence is not confined to photosynthesis; it is equally important in the chemical processes represented by respiration and in the stabilizing effect upon the elongation of stems. Third, they would make universal application of results obtained under one environment. The various laboratory experiments have been made under optimum conditions of temperature and moisture. In the trenching experiments, no thought seems to have been given to temperature. It should not be overlooked that optima of temperature as well as of moisture are unusual. Experiments aiming to determine the rôle of different factors in the life of a forest must reckon with many physical combinations. The practicing forester must ascertain what conditions prevail in his particular forest, and only then can he decide what factor should be modified in order to meet the requirements of the species concerned.

To future advocates of sunless forestry, the writer would recommend the following experiment:

Grow seedlings of recognized "intolerant" species in different degrees of shade down to about 5 per cent of full sunlight. In order to avoid introducing uncertain factors, use natural sunlight

rather than artificial light. Also avoid glass or any other medium which may cut off certain wave lengths more than others. Possibly the best solution would be to construct shades of lath spaced so as to admit the desired proportion of normal sunlight. Grow the plants out of doors in good soil under favorable moisture conditions, taking care to eliminate competing vegetation.

Repeat the series under three or four air temperatures ranging from near the minimum to the optimum for the species. To maintain the proper gradation of temperatures by artificial means under outdoor conditions would involve difficulties. It would probably be easier to stage the experiment in a mountain region where different altitudes afford the desired range of air temperature, and the distinction should be based as far as possible on effective temperatures rather than the time-honored daily mean.

Again repeat the series under favorable temperature but under different moisture and light conditions. This series probably is not necessary in order to demonstrate the effect of different degrees of radiation, but it should furnish interesting sidelights on the respective influences of radiation and root competition.

The experiment should be continued at least five years and preferably longer, in order to furnish information on the influence of light upon rate of growth, form, and general development as well as upon survival. If it is found that, regardless of temperature, seedlings of recognized light-demanding species develop normally in light intensities as low as 5 or even 10 per cent of full sunlight, the contention that light is a minor factor in silviculture would appear to be sustained.

References

1. Bates, C. G., and Jacob Roeser, Jr. 1928. Light Intensities Required for Growth of Coniferous Seedlings. Am. Jour. Bot., XV, pp. 185-194.
2. Craib, Ian J. 1929. Some Aspects of Soil Moisture in the Forest. Yale University, School of Forestry, Bull. No. 25.
3. Ehlers, John H. 1915. The Temperature of Leaves of Pinus in Winter. Am. Jour. Bot. 2: 32-70.
4. Fricke, Karl. 1904. "Licht- und Schattenholzarten," ein wissenschaftlich nicht begrundetes Dogma. Centralbl. f. d. ges. Forstwesen 20: 315-325.
5. Grasovsky, Ahimud. 1929. Some Aspects of Light in the Forest. Yale University, School of Forestry, Bull. No. 23. Pp. 53, illus.
6. Matthaei, G. L. C. 1905. Experimental Researches on Vegetatable Assimilation and Respiration. Phil. Trans. Roy. Soc. Series B, 197: 47.
7. Pearson, G. A. 1923. Natural Reproduction of Western Yellow Pine in the Southwest. U. S. D. A. Bull. 1105.
8. Toumey, J. W. 1928. Foundations of Silviculture Upon an Ecological Basis. John Wiley & Sons, New York. Pp. 438, illus.
9. ———. 1929. The Vegetation of the Forest Floor; Light versus Soil Moisture. Proc. Internatl. Congr. of Plant Sciences, 1: 575-590.
10. Wiesner, J. 1907. Der Lichtgenuss der Pflanzen.

THE OCCURRENCE OF "PITCH GIRDLE" IN SAPLING DOUGLAS FIR STANDS ON THE PIKE NATIONAL FOREST[1]

By J. ROESER, Jr.

Rocky Mountain Forest Experiment Station

The Disease

IN THE winter of 1921-22, a series of thinning plots was established in sapling Douglas fir stands on the Pike National Forest, near Sedalia, Colorado. These young stands are quite typical of the Douglas fir belt along the eastern front of the Rampart Range, and owe their origin to a combination of heavy cutting and repeated fires at the time this region was first settled, 40 to 60 years ago. It was observed, particularly at the time that the thinning study was started, that a large percentage of the young trees was affected by a peculiar stem disease, which varied greatly in appearance, depending upon the virulence of attack, and which, for the lack of definite identification, was locally dubbed "pitch girdle," since it appeared to encircle the stem of trees attacked and induced a characteristic pitch flow.

In its more malignant form, the disease, which is caused, mose likely, by a parasitic fungus, develops cankers. The first evidence of its presence is a tiny pitch flow from apparently healthy bark on the main stem, quite often at the base of a branch or even near the lower end of the branch itself. The infection seems to spread rather extensively through the outer bark and around the stem. If the conditions are favorable, it then attacks the cambium and seems to spread rapidly with the grain. In killing the cambium, a flattening of the stem, due to shrinkage, is occasioned. Disruption of the bark and the appearance of cankers follow. If conditions continue favorable to the disease and the tree is sufficiently weakened, the cambium is eventually encircled and that part of the tree above the diseased point succumbs. Quite often the whole tree is killed, if the attack is low enough on the stem. In the Jarre Canyon stands, in which the above-mentioned thinning plots are located, the disease has been found to range from the base of the trunk to approximately 20 feet up the stem. In the latest examination, some sickly trees, upon investigation, were found to be infected below the ground line, the bark being broken similarly as in diseased aerial parts.

Dr. Carl Hartley, forest pathologist in the Bureau of Plant Industry, examined specimens taken from the Jarre Canyon area in December, 1924, and in 1927 personally investigated the disease on the ground. In several respects he found the canker similar to the phytophthora canker of cacao and certain other tropical trees, but did not venture

[1] See also "Effect of Thinnings in Sapling Douglas Fir in the Central Rocky Mountain Region," by J. Roeser, Jr., in Journal of Forestry 26: 1006-1015, 1928.

to predict its identity without further study. It is probable that the fungus causing the disease is present in the outer bark of Douglas fir and has become virulent under certain favorable soil and environmental conditions. The premature killing of the outer bark after it becomes a few years old, by weakly parasitic fungi, has been found by Dr. Hartley to occur in a considerable number of species. The fact that the disease is associated in this case with overstocked stands seems to support the idea that penetration of the cambium prevails only under conditions favorable to the disease.

Dr. Haven Metcalf, also of the Bureau of Plant Industry, inspected the Jarre Canyon site and stated that the disease is not the European larch canker which has broken out on planted Douglas fir in Massachusetts. Nevertheless, the disease is new to him and, he believes, new to science. The fungus habit of spreading extensively through the bark before attacking the cambium, he has never observed in any other canker disease in this country.[2]

Whether the disease is native or introduced is, of course, not yet known. Scattering infected trees have been found in the vicinity of the Fremont Field Station near Colorado Springs and at least one of these trees is known to have been killed by the pest in recent years. Because of its prevalence on the Jarre Canyon area, it is obvious that it is too conspicuous and potentially dangerous to be ignored.

Result of Observations

At the time of the first remeasurement in December, 1924, of the four 1-acre plots included in the thinning study in Jarre Canyon, a rather superficial examination was made of the existence of "pitch girdle." This indicated the trend of the disease in regulated and in unregulated stands. It showed that the percentage of trees diseased varied inversely with the degree of thinning, and that the unthinned stand was in much worse condition than the thinned stands, with little variation among the three thinned plots. This latter circumstance was attributed, in part, to the fact that in thinning three years before diseased trees were removed wherever possible, which placed the unthinned plot in a disadvantageous light to start with. Since little is known of the mode of spread and period of incubation, it is rather difficult to isolate the factors which favor and discourage the introduction and occurrence of "pitch girdle," and for this reason a more complete analysis of each tree was made at the time the stands were remeasured in 1927.

The thinning plots involved include briefly: No. 1, an unthinned check plot, which in 1922 had 2402 trees with an average diameter of 2.6 inches; No. 4, lightly thinned to a spacing of approximately 5 x 5 feet, leaving 1490 trees of 2.3 inches average diameter; No. 3, moderately thinned to 6.5 x 6.5 feet, leaving 927 trees with an average diameter of 2.2 inches; and No. 2, heavily thinned to 8 x 8 feet, leaving 593 trees of 2.6 inches average diameter.

[2] In a more recent examination (Sept. 17, 1928), by Drs. Metcalf and Long, a fungus, *Valsa abietis* Fr., was found in occasional association with the canker, but it is not believed to be the cause of the disease since it has been collected a few times in the past on Douglas fir in Washington and Oregon where it does not appear to be associated with any canker.

The number of living and dead (since 1924) Douglas fir trees tallied in 1927 on each plot for the various diameter classes is shown in Table 1. Each diameter class includes all trees between 0.0 and 0.9 inches for the respective whole inch class. The figures in this table are used as the basis for calculating percentage of infection, etc., where the whole stand is involved.

Table 1

NUMBER OF DOUGLAS FIR TREES TALLIED IN 1927 BY PLOTS AND DIAMETER CLASSES

Plot	Diameter class 0"	1"	2"	3"	4"	5"	6"	Total
	Number of trees							
1 (Unthinned)	250	333	412	315	209	91	37	1647
4 (Lightly thinned)	192	413	396	265	158	49	13	1486
3 (Moderately thinned)	70	197	337	239	84	25	12	964
2 (Heavily thinned)	42	80	165	173	94	35	16	605

Table 2

NUMBER AND PERCENTAGE OF TREES ATTACKED BY PLOTS AND DIAMETER CLASSES

Plot	Diameter class 0"	1"	2"	3"	4"	5"	6"	Total
	Number of trees attacked							
1	50	223	324	271	167	55	18	1108
4	6	77	176	140	80	13	5	497
3	1	43	123	125	41	10	2	345
2	2	12	50	73	33	12	4	186
	Per cent of total stand							
1	20.0	67.0	78.9	86.0	79.9	60.4	48.6	67.3
4	3.1	18.6	44.4	52.8	50.6	26.5	38.5	33.4
3	1.4	21.8	36.5	52.3	48.8	40.0	16.7	35.8
2	4.8	15.0	30.3	42.2	35.1	34.3	25.0	30.7

TOTAL AMOUNT OF INFECTION

The total number of diseased trees, including dead since 1924, is shown by diameter classes in Table 2. In this classification all trees are included which showed any signs whatever of having had the disease at any time.

In 1924, the corresponding total percentages for the four plots were 45.1, 18.6, 17.9, and 16.5 respectively. Without any modifying circumstances, these figures indicate an alarming increase in the disease especially on the thinned plots, but a strict comparison is not justified because the original examination was much more superficial.

Approximately two-thirds of the trees in the unthinned plot show some form of infection, active or otherwise, while in the thinned plots the percentage likewise afflicted is quite uniform and averages one-third of the stand.

The bulk of the infection is in the 2-, 3-, and 4-inch classes, with the 3-inch class at the peak. In the unthinned stand 86 per cent of the trees in this class are diseased. At this time it is difficult to understand why this diameter class should be harder hit than those below it for the disease shows no apparent tendency to attack at any particular distance above the ground. The 3-inch class has a larger percentage of its trees in the intermediate crown class than has any other, and it will be shown later that intermediate trees are more susceptible than are either dominant or suppressed. The cause of this also is quite a mystery.

ACTIVE INFECTION

There is no standard by which the development of each individual attack may be judged, and the classification of active infection is based purely on the external appearance of the particular case, the leading clue being the presence of fresh pitch.

The number and percentage of trees which were actively diseased in the different diameter classes are shown in Table 3. In the unthinned stand, about half the diseased trees are at the present time actively diseased, while in the thinned stands from one-fifth to one-fourth are likewise affected, the percentage varying inversely with the degree of stocking. Whereas exactly two trees (on the basis of percentage) show evidence of the disease on the check plot to each one on the thinned plots, the ratio for active infection is about 2.3 to 1, indicating that the disease is not spreading quite as rapidly where the stand has been thinned.

TABLE 3

NUMBER AND PERCENTAGE OF ACTIVELY DISEASED TREES BY PLOTS AND DIAMETER CLASSES

Plot	Diameter class							
	0"	1"	2"	3"	4"	5"	6"	Total
	Number of trees actively diseased							
1	12	90	161	151	81	33	12	540
4	1	12	35	30	15	5	4	102
3	0	12	20	28	12	3	1	76
2	2	5	16	8	12	1	1	45
	Per cent of all trees diseased							
1	24.0	40.4	49.7	55.7	48.5	60.0	66.7	48.7
4	16.7	15.6	19.9	21.4	18.8	38.5	80.0	20.5
3	0.0	27.9	16.3	22.4	29.3	30.0	50.0	22.0
2	100.0	41.7	32.0	11.0	36.4	8.3	25.0	24.2

DEAD TREES

The number and percentage of trees killed as the direct result of "pitch girdle" attack since 1924 are shown in Table 4. During the three-year period between remeasurements of the stand, "pitch girdle" accounted for but two deaths in the heavily thinned stand. The percentage of loss varies directly with the number of trees in the stand, with the figure for the lightly thinned plot approaching that of the unthinned plot more closely than it does that of the heavily thinned. Because no information is at hand on the duration of the

period of incubation, it cannot be stated positively that increasing the spacing between trees decreases the possibility of infection, but this seems to be indicated. It must also be remembered that in thinning diseased trees were favored for removal according to the severity of infection insofar as this could be judged ocularly. On the other hand, it may reasonably be supposed that conditions existing six years ago have been modified, but to what extent it is not possible to state.

The percentage of all dead trees which were killed by "pitch girdle" is 74.7, 67.6, 52.6, and 20.0 in the order of decreasing density of stocking. In the unthinned control stand three deaths are due to "pitch girdle" for each one by all other natural causes, while in the heavily thinned stand the ratio stands at 1 and 4.

RELATION OF SEVERITY OF ATTACK TO CONDITION OF TREE

Table 5 shows the percentage of all diseased trees according to the severity of attack, the classification being based on the relative area of external infection and on the appearance of the canker, irrespective of the condition of the tree and whether the infection was active or otherwise.

Between one-half and two-thirds of the diseased trees are suffering a light attack at present, and from 9 to 19 per

TABLE 4

NUMBER AND PERCENTAGE OF TREES KILLED BY PLOTS AND DIAMETER CLASSES

Plot	Diameter class 0″	1″	2″	3″	4″	5″	6″	Total
	Number of trees killed							
1	12	29	22	10	2	0	0	75
4	2	8	11	2	0	0	0	23
3	0	1	7	1	1	0	0	10
2	0	0	1	1	0	0	0	2
	Per cent of all trees diseased							
1	24.0	13.0	6.8	3.5	1.2	0.0	0.0	6.8
4	33.3	10.4	6.2	1.4	0.0	0.0	0.0	4.6
3	0.0	2.3	5.7	0.8	2.4	0.0	0.0	2.9
2	0.0	0.0	2.0	1.4	0.0	0.0	0.0	1.1

TABLE 5

PERCENTAGE OF TREES ATTACKED BY PLOTS AND SEVERITY OF ATTACK

Plot	Severity of attack: Light	Moderate	Heavy	Total
	Per cent of all trees attacked			
1	51.0	30.7	18.3	100.0
4	55.1	25.9	19.0	100.0
3	65.6	25.4	9.0	100.0
2	58.1	25.8	16.1	100.0

cent are heavily infected. The ratio between the various degrees of severity does not differ much between plots and probably is always more or less the same, whether a large or small number of trees are diseased.

Of the lightly infected trees, 99.0 per cent were classed as thrifty, and only 0.1 per cent were dead. For those with a moderately heavy attack, these percentages are 89.1 and 6.1; and for those with a severe infection, 70.4 per cent are thrifty and 20.1 per cent are dead. All other trees are either sickly or belong to the class which has had the crown killed back by girdling to a greater or less extent, but is otherwise still thrifty. It is apparent, of course, that the more quickly a tree overcomes the disease, the less likely will it be to suffer permanent injury or to be killed by an attack.

TABLE 6

PERCENTAGE OF TOTAL STAND AND PERCENTAGE DISEASED BY DIAMETER AND CROWN CLASSES

D. B. H. Class Inches	No. of trees	Per cent of diameter class			Per cent diseased		
		Dominant	Intermediate	Suppressed	Dominant	Intermediate	Suppressed
0	221	....	1.4	98.6	....	....	21.1
1	329	....	15.5	84.5	....	56.9	69.1
2	403	0.5	55.1	44.4	50.0	80.6	78.2
3	310	8.3	77.5	14.5	80.0	87.6	84.1
4	209	40.7	55.5	3.8	83.5	78.4	75.0
5	90	73.3	25.6	1.1	54.5	82.6	....
6	24	95.8	4.2	....	65.2	....	....
7	8	100.0	....	....	25.0	....	....
8–11	4	100.0	....	....	0.0	....	....
Total or Ave.	1598	13.3	41.1	45.6	68.1	80.5	58.0

RELATION OF INFECTION TO DOMINANCE AND SUPPRESSION

Table 6 shows for Plot 1, in which the trees left were originally classified as dominant, intermediate, and suppressed, the percentage of all trees in each diameter class falling into these three crown classes and also the percentage of diseased trees in each crown class.

Under natural conditions, the disease does not necessarily favor suppressed trees; in fact, it appears to favor these least of all and is most prevalent on intermediates. It might be suspected that the dominant and intermediate trees have attained their relative position in the crown canopy at the expense of more intensive tissue development; in other words, faster growing trees have a larger percentage of thin-walled cells in the outer wood and bark than have suppressed trees. Relative resistance, therefore, may be associated with morphological structure which permits a tree to resist attack rather than to overcome the disease after being attacked.

RELATION OF "PITCH GIRDLE" TO SNOW INJURY

The Jarre Canyon region experienced a very heavy snowfall during the winter of 1926-1927, and damage to the sapling stand of Douglas fir was quite ap-

preciable both on and off the plots. The results of an attempt to relate susceptibility to snow damage and "pitch girdle" infection are shown in Table 7.

While 67.3 per cent of the trees in the unthinned stand are diseased, or have been diseased in the past, 75.4 per cent of the trees injured by snow carry evidence of disease which in all probability has helped to weaken the stem to some extent in one or more places. In the thinned plots, these percentages are 33.6 and 46.4; the difference being even more pronounced than in the control plot. In these, also, 63 per cent of the trees broken off by snow were diseased; in the unthinned, 75 per cent. The injurious effect of "pitch girdle" is, therefore, also emphasized along this line.

TABLE 7

RELATION OF DISEASED TREES TO SNOW INJURY BY PLOTS

	Number of plot 1	4	3	2	All Thinned Plots
Total per cent of stand showing some form of snow injury..	3.7	5.0	4.7	5.1	4.9
Per cent of snow-injured trees dying......................	8.8	10.7	13.3	6.5	10.6
Per cent of snow-injured trees diseased...................	75.4	46.7	53.3	35.5	46.4

TABLE 8

BASAL GROWTH IN DISEASED AND HEALTHY TREES IN THINNED PLOTS, 1924-1927

	Diseased trees			Healthy trees		
	Basal area (sq. ft.)			Basal area (sq. ft.)		
Plot	1924	1927	Per cent of Increase	1924	1927	Per cent of Increase
4...............	23.0364	27.3718	18.8	28.0356	34.9776	24.8
3...............	14.6416	18.8181	28.5	18.3089	24.1385	31.8
2...............	10.3315	13.2715	28.5	17.5505	23.6512	34.8

EFFECT OF "PITCH GIRDLE" ON GROWTH

It has been suspected that the disease, in the natural course of events, must have some effect upon the development of individual trees and the stand. To get some information on this, the 1924 and 1927 basal areas were calculated for healthy and diseased trees in Plots 2, 3, and 4 for the various diameter classes. These are summarized for the entire stand on each plot in Table 8.

In general, the diseased trees on Plot 4 are growing only 75.8 per cent as fast as are healthy trees; on Plot 3, 89.6 per cent; and on Plot 2, 81.9 per cent. Strangely, in the 2-, 3-, and 4-inch classes of Plot 3 the growth of diseased trees was found to exceed that of healthy trees in basal area, and no attempt is made to account for this. In all likelihood, the differences in volume increment are even greater betwen diseased and healthy trees, because quite a few living diseased trees have lost a portion of their main stem through the girdling proclivity of the disease.

The detailed basal area figures indicate also that growth interference is most acute in the smaller sizes, particularly in the 0- and 1-inch diameter classes.

CONCLUSIONS

A detailed examination of the so-called "pitch-girdle" disease on sapling Doug-

las firs in the Jarre Canyon district of the Pike National Forest indicates that under natural conditions the disease will attack approximately two-thirds of the trees, and that about 2 per cent of all the diseased trees, or 1½ per cent of all trees present, are killed annually. While this loss is not great, the heavy infection in these stands gives every cause for taking steps to study the disease in its various aspects and to eradicate it if possible. What effect it has in inhibiting growth in natural stands has not been determined, but in thinned stands the basal area accretion of diseased trees is about 80 per cent that of healthy trees. Trees in the 2-, 3-, and 4-inch diameter classes are most subject to attack, the 3-inch class especially, but the smaller sizes (0- and 1-inch) are more easily killed when once attacked. Also, intermediate rather than suppressed trees most easily fall prey to the disease; in fact, the latter class is apparently even more immune than the dominant group.

Canker scars and pitch flow, the latter being the first indication of the presence of the disease, show that the stems of trees in the stands under study may be attacked up to 20 feet above the ground. It was also found that the disease will function normally at the root collar below the ground line. Larger limbs are sometimes attacked near their base. The girdling habit of the disease usually results in killing the stem and crown above the girdle, and if this is low enough on the stem the entire tree is killed.

A recent very heavy snowfall causing considerable damage to young trees brought out the fact that diseased trees are more easily injured through bending and breaking off than are healthy trees.

Thinning has been found to be helpful not only because it eliminates diseased trees, but it appears to have retarded the spread of the disease from common centers from which it tends to spread radially into the surrounding stand. This statement is made somewhat reservedly, because a study of the number of trees diseased in 1924 and in 1927 indicates that the percentage of increase for the three-year period varied between 51 and 112 per cent. However, too much reliance cannot be placed upon the earlier figures, because the examination was of superficial nature.

The Office of Forest Pathology, Bureau of Plant Industry, plans to conduct an intensive study of this disease as soon as funds are available to assign an investigator to the project.

A NEW MENACE TO SCOTCH AND JACK PINE[1]

By J. H. ALLISON and L. W. ORR

Division of Forestry and Division of Entomology, University of Minnesota

JACK PINE (*Pinus banksiana*) is rapidly becoming one of the more important trees with which the forester must work in the Lake States region. The disappearance of the original stands of white pine (*P. strobus*) and Norway pine (*P. resinosa*) has resulted in a continually increasing area of jack pine because of the jack pine's remarkable ability to reproduce itself, especially on the poorer soils, following cutting or fires. Many areas which were formerly covered with mixed stands largely composed of other species are now covered with pure stands of young jack pine.

While Scotch pine (*P. sylvestris*) is not indigenous and has not yet been planted very extensively in this region, its seed can be obtained easily and cheaply, and its survival, after planting in the field, is high. Furthermore, it grows well, at least during youth, upon the poorer as well as the better soils of this region.

During the past, both jack and Scotch pine seem to have been comparatively free from insect pests, although the jack pine sawfly (*Neodiprion banksiana*) and the spruce budworm (*Archips fumiferana*) have recently been quite destructive to jack pine in certain localities. These two species are constantly present in sufficient numbers so that a serious outbreak of one or both is almost certain to occur as soon as we have one or two seasons or favorable weather conditions.

Recently, however, another insect enemy, the jack pine Lecanium (*Lecanium* (*Toumeyella*) *numismaticum* P. and McD.) has made its appearance in epidemic numbers in the Lake Vadnais jack and Scotch pine plantations of the city of St. Paul. If the devastation which this scale insect is causing in these plantations is any indication of what it is capable of doing in the natural stands of young jack pine it may prove to be much more destructive than anything with which we have had to contend in the past.

This insect, which is a member of the tortoise-scale group, passes the winter as hibernating fertilized females on the bark of the twigs and smaller branches of jack and Scotch pine. They are often crowded so closely together on the bark surface that they overlap like shingles on a roof. These overwintering females are cherry-red to dark brown in color, are somewhat flattened and broadly ovate in outline, and average nearly one-eighth inch in diameter. The males mature in the fall and emerge from under the thin, wax-like scales that have protected them during their development. The empty scales remain on the bark during the winter. The mature males are about one-sixteenth of an inch long and are white in color, appearing very

[1] Published with the approval of the Director as Paper No. 197 of the Miscellaneous Series of Minnesota Agricultural Experiment Station.

much like small grains of rice. They are winged and can fly about, thus insuring fertilization of the females. They disappear after mating has occurred.

The injury to the trees is due to sucking of the sap by the insects. There may also be some mechanical injury, due to the tremendous number of minute punctures made in the bark by the mouth parts of the insects. Severely infested trees have a wilted appearance. Perhaps the most characteristic symptom of infestation is the black, sooty appearance of the branches and needles. This is caused by fungi or molds which grow in the secretions from the insects. The lower branches of the trees are attacked first. The upper part of the tree usually remains free from the scale until it has become so firmly established that the tree is dying.

The plantation of jack and Scotch pine within which the attack of this scale is now going forward with great vigor is located about seven miles north of St. Paul, Minnesota, and covers an area of about 50 acres of which about 45 acres is a half and half mixture, row by row, of jack and Norway pine and about five acres is in pure Scotch pine of the Riga variety. The soil is very sandy, and is classed as "Hinckley loamy fine sand" by the Bureau of Soils (6). Of the total area of about 50 acres in this plantation, only the jack pine on about 10 acres and the Scotch pine lying directly to the east of it, have been as yet seriously attacked by the scale. The seriously attacked jack pine lies in a sort of depression whose major axis runs in a north and south direction.

This jack pine, as 2-1 transplants, was planted in 1918. In the spring of 1928, 10 years after planting, it had breast-high diameters varying from 1 to 3 inches and heights varying from 6.5 to 16 feet. The Scotch pine was also planted in 1918, as 2-1 transplants. So far it has made very satisfactory growth in spite of the sandy character of the soil. In the spring of 1928 its breast-high diameter varied from about 1 to 3 inches with the 2-inch diameter class predominating. Its height varied from 6 to 14 feet. During the summer it added on the average another 18 inches to its height. All of this stock was grown at the Cloquet Forest Experiment Station. The survival of both species, up till the spring of 1928, was high for the site upon which they are growing.

The presence of this scale upon this stand of jack pine was first noticed in August, 1926. In May, 1928, a quarter-acre plot was established within the area where the presence of the scale was first noted. At that time only a few of the trees had been killed by the scale. By November, 1928, only six months later, over 90 per cent of the jack pines on this plot were dead or dying. However, a few trees have entirely, or almost entirely, escaped. Are they resistant? If so, it suggests the possibility of developing a resistant strain of jack pine. On this same plot the Norway pine, which alternates, row by row, with the jack pine, has entirely escaped attack. Evidently it is immune.

The pure stand of Scotch pine lies directly east of the area where the presence of the scale on the jack pine was first noted. This Scotch pine was attacked by the scale during the summer of 1927. A half-acre plot located in this stand showed 27 per cent of the trees affected at the end of the first season. During the summer of 1928, all the

other trees within this plot were attacked and a few of the smaller trees, attacked during the preceding summer, died. Many of the trees still living have a wilted appearance, indicating the probability that they will die within a year.

In October, 1928, this scale was found by Dr. S. A. Graham and Mr. L. W. Orr on young jack pine trees on a tract, recently cut over, near Park Rapids, Minnesota. At that time it was impossible to determine the extent of this infestation, although some trees were observed to be nearly dead. This infestation is in a natural stand of jack pine covering an area of considerable size. In this area jack pine is the most valuable species commercially.

This scale has been present for several years on jack pine planted in Nebraska. Professor M. H. Swenk of the Department of Entomology, University of Nebraska, states (7) that it was first observed in Saline County in 1911, apparently having been brought in on nursery stock of uncertain origin. Most of the infested trees were destroyed at once, but a few were overlooked with the result that new centers of infestation soon appeared. The worst infestations now are in the northeastern part of the sandhill region, near the Nebraska National Forest. Dr. F. C. Craighead, U. S. Bureau of Entomology, states (1): "*Toumeyella numismaticum* P. and McD. has been increasing on the Forest Service plantations of jack pine on the Nebraska National Forest at Halsey, Nebraska. Several acres of pine 14 to 15 years old have been killed, and it was necessary to initiate control measures last spring."

Another infestation, on Scotch pine, was reported in 1919 from the state plantations at Trout Lake, Vilas County, Wisconsin. Specimens were sent in by Mr. Huber C. Hilton, of the U. S. Forest Service, for identification. It was then described as a new species by Professors R. H. Pettit and E. McDaniel (4). Mr. F. G. Kilp, who had charge of the control measures that were applied here, states (3) that only a few trees actually died and that, following the application of a kerosene emulsion spray, the scale disappeared. He also reports that insect parasites of the scale were abundant. Undoubtedly they were an important factor in bringing about its disappearance. Mr. Paul R. Smith, present nursery foreman at Trout Lake, states (5) that he has seen no indication of the presence of this scale during recent years.

Perhaps the St. Paul outbreak is only a sporadic one that will soon die out naturally. This plantation is slightly southwest of the natural range of the jack pine and of course entirely outside of the natural range of the Scotch pine. This fact alone may account for the extreme effectiveness of this scale in its attack upon these species locally. However, it may still prove very destructive in natural stands of young jack pine. The infestation near Park Rapids, Minnesota, should soon give definite information on this possibility.

Very little is known concerning the history of this scale in Minnesota. Professor F. L. Washburn reported (8) large numbers of a Lecanium scale on Scotch and jack pines in the Minnesota Experiment Station Forest at University Farm in 1904. Large numbers of ladybird beetles were observed feeding upon the scale and in 1906 he reported (9) " . . . . at the present time there is little, if any, of this scale upon our ever-

greens." Only a few trees were killed at that time. Miss G. Hoke, while working on Coccid material at University Farm, St. Paul, in 1923, identified (2) specimens of this Lecanium collected in 1902 as *L. numismaticum* P. and McD. She also reported it as being present in 1923. Since then, all of the Scotch pines and all but two of the jack pine trees have been removed. There are only a very few scales on the jack pine this year. It is very likely a native species and must have been present, at least in small numbers, somewhere in the natural stands of jack pine for centuries. If this is true it will probably be seriously destructive only under unusual conditions.

Is it not entirely probable that such unusual conditions now exist? Man has altered natural conditions to such an extent that the area covered by jack pine has been tremendously increased, and food conditions for any insects which attack jack pine are correspondingly more favorable. Abundance of food is one of the most important factors in limiting the multiplication of an insect species. When the restraining influence of this factor is practically eliminated, as it is now in the case of the jack pine, it is reasonable to assume that insect species that have previously been considered unimportant may assume very destructive proportions and require drastic measures for their control.

Since we know very little about the life history, means of spread, or possible control of this scale, it is evident that immediate attention must be given these questions. An intensive study at this time may result in the development of effective methods of control, and thus obviate the possibility of a general outbreak.

References

1. Craighead, F. C. 1929. Forest Insects in 1928. Forest Worker, U. S. Forest Service, Jan., p. 15.
2. Hoke, G. 1923. Catalogue of Coccidæ, in insect collection of the Univ. of Minn., p. 58.
3. Kilp, F. G. Private correspondence with L. W. Orr.
4. Pettit, R. H., and Eugenia McDaniel. 1920. The Lecania of Michigan. Mich. Agr. Col., Tech. Bul. 48, pp. 8-9.
5. Smith, Paul R. Private correspondence with L. W. Orr.
6. Smith, W. G., and N. W. Kirk. 1916. Soil Survey of Ramsey County, Minnesota. U. S. Dept. Agri. Bur. Soils.
7. Swenk, M. H. Private correspondence with L. W. Orr.
8. Washburn, F. L. 1904. Injurious Insects of 1904. Ninth Ann. Rpt. of State Ent. of Minn., pp. 183-184.
9. ———. 1906. The cabbage maggot and other injurious insects of 1906. Eleventh Ann. Rpt. of State Ent. of Minn.

CONCERNING BLACK LOCUST IN NEW YORK[1]

By J. A. COPE

Department of Forestry, Cornell University

ONE has to delve rather deeply into the files of the JOURNAL OF FORESTRY and the FORESTRY QUARTERLY to find any reference whatever to black locust. In fact in the 26 years that the Society has issued an official publication, there are to be found only three articles dealing with this species. This, it seems to the writer, is a recognition, or lack of recognition, that is not quite in keeping with the species' usefulness and service in the eastern United States, particularly with the farmer. Perhaps few foresters today would care to go as far as Gaskill in saying that "Locust is perhaps our most valuable tree species when rapidity of growth, adaptability to soil and climate and quality of wood are considered collectively."(4) In fact the tendency has rather been to discount its usefulness on account of the very serious threat of the locust borer.

Now that chestnut, which for so many decades has been recognized as an outstanding post wood within its natural range, is rapidly fading from the picture due to the ravages of the chestnut blight, it may be that further consideration of the locust would not be untimely, especially if it can be shown, as I think it can, that under certain conditions of soil and moisture excellent post material can be developed in spite of the threat of the locust borer.

The durability of seasoned black locust in contact with the soil has long been recognized by both farmers and foresters. Chapman and Miller (1) in their comprehensive forest survey of Illinois found as a result of a questionnaire sent to farmers that locust posts had an average durability of 19 years, being only exceeded by mulberry (20 years) and osage orange (40 years). The Forest Products Laboratory at Madison credits black locust posts with an average durability of 20 years in contact with the soil. On the basis of observations here in New York, these figures seem quite conservative. Well-authenticated records are available showing 75 years of life for round locust posts of average size, and 50 years for sawed locust grape stakes that were not more than 12 square inches in cross section at the top. A complete post survey in any region would tend to pull down these high figures somewhat, but not, it is believed, enough to make the average as low as 20 years.

This immediately brings up the question often asked the writer, to which he has as yet found no satisfactory answer: "What is the difference between black and yellow locust, or black and white locust?" Botanically there seems no distinction, but certainly as the names imply there is a distinction in the wood. In the "black" variety, the heartwood is dark with a narrow ring of paler sapwood, while in the other variety, there is practically no color distinction between heart and sapwood, the stem

[1] Presented at the meeting of the New York Section, Society of American Foresters, Albany, N. Y., January 30, 1929.

in cross section presenting a lemon-yellow color. It would seem probable that this latter variety would not be as durable in contact with the soil, and that differences in authentic records might thus easily occur. It has been suggested that this difference in color of the wood might be due to differences in soil conditions where grown, though no actual facts have been advanced to defend this position.

Mr. Henry Hicks of Westbury, Long Island, claims that the two locusts are different varieties and points them out growing side by side in certain parts of the Island. The " black " variety, on Long Island, at least, seems to have a very pronounced fastigiate habit with very little tendency of the main stem to fork, while in the other variety the crown is quite deliquescent, especially when open grown, with an early tendency to fork low down. The writer has noted similar differences in habit in a few cases elsewhere in the state, and it may be that this distinction is not peculiar to Long Island. The abundance of black locust of this pronounced fastigiate habit is one of the striking features of the North Shore of Long Island. According to local accounts, locust was first introduced early in the 19th century by a sea captain returning from southern Atlantic ports. From this early planting, it was propagated and distributed generally over the higher land in the northwestern section of the Island by means of root cuttings. The Long Island variety does not seem to seed prolifically as does the locust elsewhere.

Black locust is not native in the rest of New York State, and yet there is practically no part of the state where it is not found as a dooryard tree, whence it has spread by seed and root suckers to make scattered clumps along roadsides. It must indeed have had an excellent reputation among early settlers to have been secured at no small pains from points well to the south and to have been planted out so commonly. The fragrance of the blossoms may have had something to do with it, as well as the superstition that it safeguarded the homestead from being struck by lightning.

Locust as a Post Material

It was not until much later in the agricultural development of New York State that recognition of the value of the locust as a post mateial prompted landowners to set it out in plantations. Outside of the Long Island plantings, probably the oldest locust plantation on the mainland of which there is authentic record was made in 1842 on the Ham farm in the town of Washington, Dutchess County. Fifty years later a considerable portion of these trees were cut and sold to a New York contractor for cribbing purposes, and from this original plantation an adjacent area is completely covered with young locust, developed both from seed and root suckers. In fact the soil of a great deal of Dutchess County seems particularly adapted to black locust and it is safe to say that there is today more volunteer growth of this species in Dutchess County than in any other section of the State. One cannot travel out of Poughkeepsie in any direction without noticing the young groves springing up along fence rows and in abandoned fields adjacent to older isolated specimens.

In Seneca County a 50-year-old plantation of black locust is still standing,

though it seems not to be as happily located or acclimated as the plantations in Dutchess County. A sample area measured in 1926 showed an average height of 58 feet and an average diameter breast high of 10 inches. The maximum diameter was 18 inches and a considerable number were in the 12-, 13-, and 14-inch classes. The original spacing was 8 x 8 feet, calling for 640 trees to the acre; this has been reduced by competition to 480 trees to the acre. An ocular estimate indicated about 2330 standard 7-inch posts to the acre. The trees, however, were not thrifty in appearance; all of them were flat-topped and some stag head was in evidence. If they had been cut 15 to 20 years ago, a greater yield per year would undoubtedly have been shown.

In contrast to this stand is an 18-year-old plantation of black locust in the town of Groton, Tompkins County. These trees averaged 50 feet in height, with 304 living trees per acre, though the original spacing was 6 x 6 feet. The average diameter was 5.2 inches and the volume per acre was 1418 cubic feet. An ocular estimate indicated 836 7-foot posts to the acre.

This yield compares reasonably well with actual cutting done on the black locust plantations of the Pennsylvania State College and reported in the annual report of the director for 1926. An 18-year-old plantation gave 1064 posts per acre.

There are other excellent plantations in New York State, notably in Wyoming, Schoharie, Oneida, Columbia, Cattaraugus, Schnectady, Chautauqua, Saratoga, Cayuga, Onondaga, and Yates Counties, which are of sufficient age (over 15 years) to show that black locust can develop in spite of the borer. And this wide range of distribution, with obviously varying soil conditions, indicates that the successful growing of locust is not confined to any one section or soil.

The Threat of the Locust Borer

On the other hand we cannot blindly shut our eyes to the fact that the locust borer is an ever-present threat to successful locust post growing in New York State. Gaskill's figures of the yield of hundreds of acres of planted locust in Hungary show the possibilities of this species, but it must be remembered that the European foresters left the borer at home when they imported the black locust.

I have taken particular pains to examine young locust trees wherever I have come across them in trips around the state both in plantations and along fence rows, and in no case have I failed to find (if I searched diligently) evidence of the locust borer attack on young locusts. The excellent plantations already referred to have developed to post size in spite of the borer, and on the other hand there are plantations that have been almost total failures because of the borer.

The classic example is the Pennsylvania Railroad plantations of 1908 in New Jersey, and yet the plantation at Pennsylvania State College was some of the same stock, set out at the same time, and yielded over 1000 posts per acre 18 years later. One of the worst examples of locust borer damage in New York State in a plantation of any size was the one in Letchworth Park established in 1912. This was so badly infested with borer that it was finally cut for fuelwood in 1926. And yet not 20 miles away is a 20-year-old plantation from

which posts are already being harvested and the borer damage is not appreciable. This would seem to indicate that there must be some soils better adapted to growing locust than others, and that on the better adapted soils posts are developed in spite of the presence of the borer. Let us examine into this phase of the problem a little further.

Soil Requirements of Black Locust

We learned in our forest school days that *Robinia pseudacacia* belonged to the legume family, but I am doubtful if many of us associated this fact with the well-known function of members of this family to convert free nitrogen from the air into available nitrogen compounds by means of nitrogen-fixing bacteria on the roots (*Rhizobium leguminosium* in the case of black locust).

The presence of these nitrogen-fixing bacteria in nodules on the roots of black locust must obviously have a very marked effect on the growth rate, since where these nodules are present additional nitrogen is made available to the host plants.

Professor Ferguson's note in the Journal of Forestry for March, 1922 (3), gives some corroborative information on this point. An examination of an 11-year-old catalpa plantation immediately adjacent to a locust plantation of the same age showed the following results in the nine rows nearest the locust plantation:

Row	Ave. D. B. H. Inches	Ave. height Feet
1	3.3	26.8
2	3.5	24.6
3	2.7	20.5
4	2.1	15.2
5	1.4	10.0
6	1.9	11.3
7	1.1	7.6
8	0.9	6.5
9	0.7	0.5

Further corroboration of this fact is found in the statement frequently made to the writer by observing farmers that any annual crop does fully as well if not better right up to the fence adjoining a row of locust trees as it does out in the field. This certainly would not be true with other common roadside trees such as maple or elm.

This striking effect of locust on soil fertility noted by Ferguson opened an interesting line of thought. It is a well-known fact that certain of the legumes, such as alfalfa for instance, thrive only in non-acid soils. In fact, it is a common practice for farmers in New York State contemplating establishing a field of alfalfa to have the soil tested for its acidity, and if it is found acid the field must be treated with lime before alfalfa can be grown. To insure the best results from bacterial action after the soil has been neutralized by applications of lime, it is the practice of the New York State College of Agriculture to furnish inoculation not only for alfalfa but for other legumes, such as beans, peas, and clover.

With this general practice in mind, samples of both surface soil and sub-soil were collected from many locust plantations in the state, notably the ones in Tompkins County already referred to and in Onondaga, Wyoming, and Chautauqua Counties.

The Tompkins County plantation, which shows the best growth rate of any that has come under the writer's observation, is on a steep hillside underlain with limestone. The soil is not acid and the surface rootlets on several trees picked at random are well covered with nodules indicating the presence of bacteria. In the Wyoming and Chautauqua planta-

tions about 1500 pounds of lime to the acre would be required to neutralize the surface soil, but there were also nodules present in both plantations. Neither of these plantations shows the growth rate of the Tompkins County plantation. There are other factors entering in, however, and it could not be said that the lessened growth rate is due entirely to the more acid nature of the soil.

It does seem fair to the writer, however, to assume, on the basis of the foregoing and pending more definite research on the subject, that black locust properly inoculated and established on non-acid soils has a fair chance in New York State of surviving in spite of the ever-present locust borer.

In 1926, special inoculation was prepared at Cornell and forwarded to the Conservation Department for treating its black locust seed beds. Probably all the seedling locust now sent out from Saratoga shows the presence of nodules on the roots since it is the practice of the nursery foreman to grow his locust in one site from year to year, and once the beds are inoculated they remain so.

From such rough experimentation as the writer has undertaken, it is clear that the black locust bacteria are more acid tolerant than the alfalfa bacteria, but on just how acid a soil they may be expected to survive is one of the problems that research must solve. In that connection, it should be remembered that a great deal of our abandoned land on the Volusia and Lordstown soils of central and southern New York is highly acid in character. Certainly with our present knowledge, it would be a mistake to recommend planting this species on such soils.

Further About the Locust Borer

F. C. Craighead in his bulletin on the control of the locust borer (2) has noted the difference in borer damage in different plantations and ascribes it to varying conditions above ground more or less favorable to the adult beetle. He sums up by saying that black locust can be grown profitably on a commercial scale if the locusts are planted in thick stands or mixed with other trees so as to produce a densely shaded condition and natural pruning during the first 10 years of growth. Certainly due weight must be given to the observations of so competent an entomologist. However, the plantations under his observation were located chiefly in Virginia and Pennsylvania. They did not include any plantations in New York.

The factors that Dr. Craighead found so important in controlling locust borer have not seemed to operate in those plantations in New York State which have come under the writer's observation. For example, last spring the writer dug young locust borer larvæ from the outer layers of wood from the center of a 10-acre, 15-year-old locust plantation. This plantation had been established by the seed-spot method and the trees had an average spacing of 5 x 5 feet. The stems on which the adult beetle had deposited their eggs were certainly in shade. On the other hand many open-grown locust trees without any shade around them have been observed which are growing vigorously and not appreciably checked by borer damage. The 15-year-old borer-attacked locust plantation was developing rapidly into posts in spite of the borer, because the site was adapted to locust and the resultant growth rate was such

that the trees was able to throw up a strong wall of wood around the larval galleries, and thus prevent the tree from breaking over at the attacked point. In the Tompkins County plantation, which has already been characterized as the best in the state, those trees that fell behind in the competition for a place in the sun were given their final death blow by a liberal dose of locust borer larvæ. Those trees whose tops had full access to the sunlight and were growing vigorously presented a smooth straight trunk. A little chopping with the axe into the trunk, however, was sure to reveal borer galleries, surrounded by a good layer of wood. Under such conditions, it is quite obvious that the straightness or durability of the posts have not been appreciably affected.

Cultural Operations

After the planting site for black locust has been selected, some preparation of the land is to be recommended. The writer has seen too many failures from young locust set out in sod to feel that it is proper to treat locust seedlings the same as we do coniferous planting stock. Nor is it enough simply to plow the land. The plantation must be cultivated for the first year or two to give the seedlings opportunity to get thoroughly established, after which they can take care of themselves. One other cultural operation should not be overlooked and that is pruning during the second or third winter to prevent low forking. One farmer in Columbia County has had great success at this, as reported in the annual report of the Conservation Department for 1926.

Harvesting probably had best be started as soon as the trees reach 6 inches D.B.H. These will give 2-3 round posts per tree, and on good soils should be produced in 20 years. Posts should be cut in winter with low stumps to enable the sprouts to cover the old stump effectively. Probably not more than two sprouts should be left to a stump. The second crop should be obtained by the fifteenth year. One grape grower in Chautauqua County is already growing his third crop of stakes from one set of stumps.

Conclusions

The importance of black locust as a post tree in New York State has been enhanced by the diminishing supply of other suitable post woods. Inspection of existing plantations in the state shows that while the locust is everywhere pretty generally attacked by the locust borer, on certain soils, non-acid or only slightly acid in character, the growth of the locust is so vigorous that the damage caused by the locust borer larva is not serious.

Further experimentation and research is needed to determine: (1) whether or not there are two distinct strains of black locust, as seems apparent on Long Island and to a limited extent elsewhere, with actual figures on the relative decaying resistant quality of the two strains; (2) the degree of soil acidity in which black locust can be grown successfully; (3) the effect and value of inoculation of seedling stock at the nursery; and (4) the relationship between borer damage and soil factors, the presence or absence of golden rod, and the character of the locust planting, whether mixed or pure.

This research and experimentation is well justified because to two great agri-

cultural industries of the state, dairying and grape growing, posts and stakes are essential. No tree that can be grown in New York is better adapted to meet these needs.

References

1. Chapman, H. H., and R. B. Miller. 1924. Second Report on a Forest Survey of Illinois. Urbana, Ill.
2. Craighead, F. C. 1919. Protection from the Locust Borer. U. S. D. A. Bull. 787. Govt. Printing Office, Washington, D. C.
3. Ferguson, J. A. 1922. Influence of Locust on the Growth of Catalpa. Jour. of For. 20: 318-319.
4. Gaskill, Alfred. 1906. Growing Locust in Hungary. For. Quar. 4: 106-111.

USE OF AIRPLANES IN FORESTRY[1]

By LEONIDAS COYLE

State Forest Firewarden, Department of Conservation and Development, New Jersey

IN DISCUSSING the use of airplane as an aid to forestry I have in mind the cheaper, smaller plane with engine power of about 125 horsepower; three passenger, open cock-pit; ground speed of from 60 to 120 miles an hour, depending on the direction and strength of the wind; ability to maintain with practical safety altitudes of from 500 to 10,000 feet and a cruising radius of from 300 to 400 miles; and operating over the type of country found in the Allegheny states—mountains and coastal plains, fairly densely inhabited, with airports within a hundred-mile radius.

The principal uses to which this type of airplane can be put under these conditions may be considered under the following heads:

1. Preliminary reconnaissance for type, growth, etc.
2. Taking of aerial photographs.
3. Patrolling for the discovery of forest fires.
4. Control and management of large fires.
5. Mapping and checking of burned areas.
6. As a quick method of transportation.

Not only can a great deal of preliminary reconnaissance be accomplished in a very short time with the use of a plane, but a much better, general idea of the types, growth, and amount of timber can be obtained than on the ground. By flying at low altitudes of from 500 to 2000 feet, it is not difficult for anyone who is generally familiar with tree types and ages to recognize these types and their approximate size, and to note and record with a fair degree of accuracy the areas covered by them. The observer from an airplane could easily accomplish this over a territory of 150 square miles of forest in a day. If he has at his disposal fairly good maps, he can put on them enough data to give a good idea of what the territory contains in the way of forests. He can also determine to a large extent the best routes for roads, trails, etc., to open up this territory.

Aerial photographs are of two kinds, vertical or oblique, depending on whether the axis of the camera was perpendicular or inclined to the face of the earth when the picture was taken. Both may be useful, but the vertical photograph is necessary for mapping and follows the topographical features in the proper relationship to each other in the same scale. As the vertical photograph shows less territory on a larger scale than an oblique photograph taken from the same altitude, the vertical photograph is more valuable for showing details. It has the disadvantage that the relief is not so ap-

[1] Presented at the meeting of the Allegheny Section, Society of American Foresters, Harrisburg, Pa., March 15, 1929.

parent as with the oblique, and must largely be deduced from other features shown in the photograph; but for detailed study of the forest, a large scale photograph, where features are shown in the same scale, makes a vertical photograph more desirable. Vertical photographs are usually taken at altitudes of from 1500 to 10,000 feet. This gives a small picture which must be greatly enlarged to be of practical use. Oblique photographs are made at comparatively low altitudes, usually with the axis of the camera at an angle of about 30° below the horizon. While these photographs do not show the same amount of detail, they are very useful in conjunction with the vertical photographs in revealing contours and other characteristics of the territory.

Familiarity with the aspects of the forest in actual flying is an advantage in interpreting these maps, and ability to interpret increases rapidly with experience. There are a few simple rules which will help in reading aerial photographs. If a photograph is held so that the shadows fall towards you and you face your source of light, either window or lamp, where this light will fall upon the picture in the same relative position as the sun was with respect to the ground at the time the photograph was taken, the relief will appear natural. If it is held with the shadows falling away from the eye, the relief will appear inverted; the cuts will look like embankments, and the embankments will look like cuts. An ordinary map should be used as an aid to interpretation. This map and a photograph should be put side by side and oriented. This will help in identifying important topographical features shown on both, and in determining and visualizing the relief of the terrain. Oblique photographs of the same territory will be found valuable for the same reasons. Examination of the picture with the aid of a reading glass and pointer, concentrating attention on each detail instead of trying to study the photograph as a whole, and making full use of all recognizable features which appear on the map, will give a great deal of information and make the aerial map very valuable to the forester. A much greater detail of areas of growth is possible with the photograph than would be feasible to obtain by a ground survey. If this detail is necessary or advisable, the aerial photograph will be found much cheaper and much quicker than the ground survey.

The use of an airplane for fire patrol has these disadvantages: To come within a reasonable expenditure, and airplane would have to patrol 5000 square miles. In patrolling territory of this size, the patrol would necessarily be intermittent and the danger of depending on an inintermittent means of fire detection is obvious, where the spread of fire is at all rapid. Under certain weather conditions, large fires may be discovered from an airplane at a distance of 40 or 50 miles, but at that distance it would be impossible to pick up the small fires, or fires at the start, which it is the mission of the observation system to detect. It would seem that, except in the very worst fire weather, and then only as supplementary to other observation systems, the airplane would hardly pay for itself in this particular work.

As a means of control and supervision, the airplane marks an epoch in the progress of the control of large fires. A fire that has advanced three or four miles

will probably have a perimeter of 30 or 40 miles, and it will usually be necessary to extinguish every foot of this line of fire 40 miles long. To do this promptly and to make the best use of the forces at his command, the man in charge of the fire must have an accurate knowledge of the location and extent of the line of fire. Making a reconnaissance to get this information, either on foot, mounted, or with the aid of an automobile, will take him a great many hours, during which time the line of fire is constantly changing and advancing, and as a result he never has a clear idea of his problem.

On the other hand, it is an easy matter with a little training for an observer from an airplane to plot on a map an accurate outline of the fire. The actual plotting can be accomplished from the air in 10 or 15 minutes, and with proper liason established a tracing or over-lay of the fire can be furnished to the chief in charge of the ground forces at the fire every 30 minutes, if necessary. The plotting of the fire, if maps are available to the observer, is a comparatively simple process. He has only to establish the relationship between the ground distance, as seen at his flying altitude, with that of his map distance, to draw fairly accurately the line of the fire. It is very much like sketching the features of a map of one scale on a map of another scale which you place alongside of it. The observer, because he has a comprehensive view of the fire, can make a clear estimate of the situation and give much valuable advice to the ground forces. In New Jersey, during last year's fire season, there is no record of any fire having rekindled or escaped the day after it started. This we attribute to the use of the airplane, as indicated above.

The use of the airplane for transportation has its advantages and its disadvantages. The chief disadvantage is that it is available only where there are proper landing facilities. The chief advantage is that where an automobile would probably have to travel 40 or 50 miles to reach a certain place, the airplane, following an air line, can arrive by travelling from one-half to two-thirds the distance.

No matter how desirable the use of an airplane may be, it goes without saying that its cost may be prohibitive. This would probably be the case where a state department must maintain its own air service unless there were enough work to keep the plane in constant use. In round numbers, the cost of maintaining an airplane is as follows:

Original cost—between $3000 and $4,000, with a probable five-year life.

Pay of mechanic—about $2200 a year.

Pay of pilot—about $5000 a year.

Hangar and machine shop—about $1500 a year.

Gas and oil—about $2000 a year.

Spare parts and tools—about $300 a year.

This makes a total yearly cost of about $12,000, which would necessitate 400 hours of flight before it would be a paying proposition. This figure might be reduced by half if use were made of the pilot, mechanic, and hangar of a commercial air port. Where the proper personnel is available, arrangements can be made with the commercial organization to provide the airplane and pilot at a cost of about $30 an hour for the actual time in the air. The pilot and photographer for photographic work must be highly trained specialists and are not available at most air ports, but

there are several firms in the East which make a specialty of this work and will guarantee the results in good workable form as cheaply as $10 per square mile, or $1\frac{1}{2}$ cents per acre, up to as much as $50 per square mile. The price depends on scale of negative, size and shape of area, distance from flying base, etc.

When it is taken into consideration that the average speed in which the ground is covered by an airplane is about 100 miles an hour, the cost of $30 per hour of flight means about 30 cents a mile, and if consideration is given to the fact that the air routes are much shorter than the ground routes, the mileage is not more expensive than the usual rates for a car and driver; and in the long run, when the time element is considered, it is decidedly economical.

Considering the airplane as an auxiliary to forestry along the lines cited, it will be found that it is not only less expensive than the same work would be from the ground, but that it can do work otherwise impossible.

FOREST FIRE EXTINCTION COSTS IN PENNSYLVANIA[1]

By HENRY CLEPPER

Forester in Charge of Field Research, Pennsylvania Department of Forests and Waters

IT HAS BEEN said that "forest fire prevention is not a science. It is just common sense." This may be true. But forest fire extinction has for years been gradually becoming an art based on scientific principles. Despite the reams of articles written on the subject, there is nevertheless a lack of information concerning the cost of forest fire extinction in relation to the various size classes of fires extinguished.

In Pennsylvania, where practically all woodlands in the state are overlooked by fire observation towers, and where foresters, inspectors, and fire wardens are immediately available to respond to fire calls, forest fires are extinguished at a cost which is about the minimum that can be expected until some more effective system can be set up to replace the voluntary warden system now in vogue. On the whole the state fire wardens are generally experienced in fighting fire, they are equipped with modern tools, they get to fires when the fires are reported, and the observation towers detect the fires almost as soon as they start. Undoubtedly future refinements in the present organization will result in smaller areas burned and lower extinction costs, but as at present constituted the service has attained a status of efficiency where there is, or should be, a definite relation between the size of a fire and the amount of man power required to extinguish that fire.

One forest district may have as few as five fires a year, another may have as many as 500. The forester with five fires may not be troubled with a so-called "fire problem"; the one with several hundred fires is vitally concerned about the costs of extinguishing those fires and the area that they burn.

At the end of each year appears a summary of fire data for the entire Commonwealth, giving, among other things, the average cost of extinction per fire for the whole state and the average area burned per fire. The forester whose figures fall below these averages for the state as a whole is elated. If his figures for one or both of these items rise above the average for the state at large, he looks for an alibi. And, incidentally, he very frequently finds one—and a good one, too!

For example, a fire that burns 25 acres a whole and individual districts is good enough as far as it goes, but, failing to take into account the fact that all sizes of fires are mixed up in the figures obtained, it neither gives the forester a criterion by which to estimate progress in fire extinction in his district, nor sug-

[1] Presented at the meeting of the Allegheny Section, Society of American Foresters, Harrisburg, Pa., March 15, 1929.

gests ways to correct faulty extinction methods.

Nor is it necessarily a satisfactory attainment for a district to meet or fall below the state average, because this should not be a goal in itself. The forester whose district falls below the state average in cost of extinction and acreage burned per fire may be imperfect in his methods and slovenly in his procedure, and good fortune alone may have permitted him to come through the season with results, which, superficially, appear better than the average. While it is desirable and commendable for the forester whose district is above the state average to make efforts to get below it, yet it must be recognized that this average is not a goal to strive for, but has been, and should remain, a kind of sliding rule whereby the forester measures his efforts toward attaining the highest efficiency in his organization.

Let us say a forester receives a bill for the extinction of a 25-acre fire; one that burned under average conditions, was promptly detected and attacked, and was extinguished without any later "break-outs." The bill for labor alone is $85, with 50 men working at the fire. Is the cost for labor high for a fire of that size? If so, how high? Were more men present than were needed? How many more? If the cost was too high for 25-acre fire, would it be too high, or too low, for a 50-acre fire?

Or, let us state the problem this way: What should the approximate labor cost have been on this 25-acre fire, and what number of men should have extinguished it?

It will here be objected, no doubt, that individual fires vary so greatly and the human factor enters in to such an incalculable extent that the labor cost and the man power required to extinguish a fire of a given size cannot be constant, even approximately. Let us see.

The writer recently made a study of the costs and number of men required to extinguish fires in Pennsylvania of various size classes. The data were obtained from the records of the Department of Forests and Waters in Harrisburg, and covered the year 1927 and the spring of 1928. To obtain accurate results for each size class, more than 50 per cent of the fires for these two years were studied, the records being taken indiscriminately without any attempt to work toward a preconceived answer.

It will be noted from Table 1 that fires over 300 acres in size were not included, since by the time a fire reaches that area too many mistakes have probably been made to give later data which would be of any value. Similarly, the writer questions whether the data for fires between 201 and 300 acres in size can be of much use, for the costs of fires in this size class vary considerably. However, the figures for the several size classes under 200 acres will be most useful, since more than 90 per cent of the fires in Pennsylvania burn less than 200 acres each.

It may be explained that the number of fires listed for each size class at which outside help was contributed is included in the number of fires studied of that size class. For example, there were 237 fires studied in the 1-10 acres class, and of this number outside help was contributed on 34 fires. In other words, approximately 14 per cent of the fires in Pennsylvania that burn from 1 to 10 acres have outside help contributed in their extinction; and this outside assistance

averages seven men who work a total of 15 hours on each fire. On the other hand, the figures showing cost per fire and number of men per fire under the heading "Costs Incurred by State of Penna." do not include help contributed by coöperators.

Probably the figures in this table are of greatest use in cases where a forester receives bills which have labor charges greatly in excess of those for the average for the state. For instance, a forester receives a bill of $85 for labor for a 25-acre fire which had been reported promptly and extinguished without undue loss of time. Not knowing what the average labor cost is for a fire of this size, he may never realize that the fire automatically should be investigated and that probably one of two things happened: either the acreage as reported is less than actually burned, or else there were more men on the fire than were needed. For the average fire of 25 acres in Pennsylvania is extinguished by 15 men, and the labor cost is $21.70. Not all fires are going to approximate these figures; there are wide variations caused by tardiness in attack, poor judgment, high winds, and all the other factors that enter in. But since these figures are "average" figures, they may be a guide in assisting foresters on "average" fires.

Columns 5 and 6 in Table 1 show by size classes the average labor costs and the number of men who fight fire in amounts which have been rounded off. Generally, it may be said that any fire which exceeds either of these two amounts is not an average fire and lends itself to investigation. The farther a fire exceeds these figures, especially in cost, by that much it automatically requires investigation.

For example, a fire that burns 25 acres and shows a labor cost of $50 exceeds the average by only $10, and might be passed without notice. On the other hand, a 25-acre fire costing $85 for labor, more than twice the average for the state, would require investigation.

The rounded-off figures suggest a few departures from the policy at present in vogue in forest fire organization in the state. These departures may or may not find favor with foresters, but they are outlined in the belief that any suggestion that may help better the forest fire extinction organization will be welcome.

Crews. The ordinary forest fire crew consists of four or five men and a warden, and ordinarily only sufficient tools

TABLE 1

COST AND NUMBER OF MEN USED PER FIRE BY SIZE CLASSES

	Costs incurred by State of Penna.					Help contributed by coöperators			
		Actual average		Rounded off					
Size class acres	No. fires studied	Cost per fire	No. men per fire	Cost per fire	No. men per fire	No. fires	Per cent of total number	Avg. no. men per fire	Avg. no. hours per fire
1 to 10	237	$9.71	10	$10	10	34	14	7	15
11 to 25	265	21.70	15	25	15	42	16	9	40
26 to 50	219	37.40	21	40	25	53	24	14	65
51 to 100	220	63.70	28	65	30	65	30	15	73
101 to 150	74	97.65	39	100	40	27	39	18	144
151 to 200	55	152.28	49	160	50	15	27	19	119
201 to 300	35	168.04	59	175	60	14	40	20	128

to equip this size crew are furnished to the warden. Since the average 1-10 acre fire in Pennsylvania is extinguished by 10 men, and since the department's goal has been "90 per cent of the fires under 10 acres," it may be well to reorganize the crews on a basis of 10 men each and to furnish tools for 10 men.

This size crew may or may not be the optimum for perfect fire fighting, but since it is what we are now using on 1-10 acre fires it seems wise to employ at once the force necessary to combat fires of that size throughout the state. But here an apparent fallacy arises: With our fire wardens' crews now organized on the basis of five or six men, we nevertheless get 10 men on the average fire of 1-10 acres. Now, if we proceed to organize the crews on a basis of 10 men, may we not get 12 or 15 men on the 1-10 acre fire? It is entirely probable that we shall, and at the same time increase our costs for the 1-10 acre fire over what they are now, namely $10. But—and this fact is worth emphasizing—by recognizing each fire as being an average fire of the small class, and by throwing in sufficient forces to combat such a fire, we may be able to prevent the 1-10 acre fire from increasing to a 100- or 200-acre fire.

In other words, by increasing the size of our crews we shall increase the cost of extinction of the smaller fires, particularly in the 1-10 acre class, but incidentally we may be able to lower the total acreage burned and eventually the total costs of extinction.

Labor Costs. The labor cost of extinguishing fires under 300 acres in size averages roughly $1.00 per acre. This figure may then be used as an approximate cost per acre beyond which fires should generally not rise. It is true that foresters have for some time been using just this figure, without, however, any such authority as that furnished by Table 1.

Man Power. As fires become larger in size, the number of men required for their extinction does not increase in the same proportion as the labor cost.

Thus, a 200-acre fire, which is 20 times the size of a 10-acre fire, uses only six times as many men, while the cost of extinction is 17.5 times as much.

It must be remembered that these figures do not necessarily show what is desirable but rather what actually happens. They indicate that what is needed is a larger initial man power to fight fires in their early stages. It now frequently happens, when a small crew is sent to a fire which increases in size faster than the crew can extinguish it, that more men are thrown in as deemed necessary. But the man power lags behind the rate of spread of the fire until it happens that a 200-acre fire may be under way, and then in desperation men are often thrown in by the dozens.

It does not follow, because 60 men extinguish the average 200-acre fire, that in all cases 60 men must be provided. What does appear to occur is that the 200-acre fire became so large because sufficient men were not at the fire earlier. In brief, we return to the 10-man crew idea, recognizing that this number combats the average 1-10 acre fire successfully, and that while it is more costly to throw in two or three 10-man crews on a 20-acre fire, the expense may be justified since the area burned is kept down and ultimately the cost of extinction reduced, even though the labor cost for the smaller fires is increased.

Estimating Area Burned. Forest fire figures, if they are to mean anything at all, should be based on as accurate information as it is possible to obtain. The labor costs, organization costs, office costs, and all other costs pertaining to the protection of forests from fire can usually be estimated beforehand, and the data relating to forest fire extinction organization costs are consequently known down to the last cent. Not so with the area burned. The fact that frequently fire wardens and inspectors, and occasionally foresters, appear to be poor judges of this, indicates that a better system of obtaining acreages should be provided. After all is said and done, it appears that the only method that will consistently give fairly accurate and yet quick results is to make compass surveys of each fire that burns more than 25 acres.

With areas surveyed instead of merely estimated, which frequently means guessed, forest fire extinction can be placed by any forester for his district or by a statistician for the state at large on an accurate labor-cost-acreage basis, which is where it should be if forest fire extinction is to become a science and not just common sense.

FOREST FIRES IN CENTRAL MASSACHUSETTS
THEIR CAUSES AND COST TO THE COMMONWEALTH[1]

By PAUL W. STICKEL

Assistant Silviculturist, Northeastern Forest Experiment Station

THE following brief account of the causes and cost of forest fires in central Massachusetts is an analysis of the fire reports for the months of March to November during the period 1926 to 1928 inclusive. The total land area involved is 2,521,056 acres, which embraces all of Worcester County (1,001,774 acres), the eastern halves of Franklin, Hampshire, and Hampden Counties (304,732 acres, 252,789 acres, and 430,907 acres, respectively), the western half of Middlesex County (523,394 acres), and one town in Norfolk County—Medway (7,460 acres). Of the total land area, 1,258,449 acres (50 per cent) is classed as forest land, being covered chiefly with a growth of northern white pine and eastern hemlock in various mixtures with hardwood species.

The average number and average per cent of fires per year by causes is presented in Table 1. As is common throughout the New England states, practically all the fires were man-caused. But one fire during the three years was attributed to lightning. Listed in their order of magnitude the four principal causes of fires were unknown, smokers, railroads, and brush burning. These four alone accounted for an average of 668 fires per year, or 84 per cent of the total. In spite of the fact that there is a brush-burning permit law in the state, 108 fires annually (15.8 per cent) were caused by this factor. As nearly as could

TABLE 1

CAUSES OF FOREST FIRES IN CENTRAL MASSACHUSETTS, AVERAGE PER YEAR, 1926-1928, INCLUSIVE

Cause	Number	Per cent
Unknown	205	25.2
Smokers	183	22.5
Railroads	172	21.1
Brush burning—permit	26	3.2
Brush burning—no permit	102	12.5
Children	55	6.7
Incendiary	22	2.8
Miscellaneous	22	2.8
Fishermen	9	1.1
Construction	7	0.8
Camp fires	5	0.6
Lumbering	5	0.6
Hunters	1	0.1
Lightning	...	...
Total	814	100.0

be ascertained from the original fire reports, 102 fires each year (12.5 per cent) were the result of people burning brush without a permit, while 55 fires each year (3.2 per cent) were caused by brush-burning permittees.

The occurrence of fires by months (Table 2) indicates clearly that in central Massachusetts the forest fire hazard

[1] The writer wishes to express his gratitude to the Division of Forestry, Massachusetts Department of Conservation, for the loan of the State forest fire records and for furnishing the data on the forest area of Massachusetts.

is most acute during the months of March, April, and May, particularly the two latter. Annually during these two months 662 fires (81.4 per cent of the total) occurred, burned over 12,116 acres (93.1 per cent), caused $96,124 (94.9 per cent) damage, and cost $19,048 (91.4 per cent) to suppress. Two chief factors contributing to the extreme hazard during these early spring months are the hardwood foliage and the weather. Between late winter and late spring there is an interval during which the hardwood leaves are either lacking or incompletely developed. Such a condition leaves the forest floor with its dead plant remains fully exposed to the drying-out action of sunlight, high air temperatures, high winds, and low relative humidities.

Table 3 may be considered as the cost account of forest fires for the region under consideration. It shows the number of fires, area burned, damage, suppression costs, number of men used, and man hours worked by area classes of fires. Of special interest are the following points brought out by this table:

The greater number of fires were five acres or less in size (619 fires, or 76.2 per cent), which, however, burned over only 1097 acres (9.0 per cent) annually. As was to be expected the greatest damages reported were for the larger fires, especially those 500 acres or more in area. The chief reason for the low damages given for the smaller fires was that no damages were reported for them except in cases of destruction to buildings, fences, lumber, etc.

While the annual area burned and damages were small for the fires 5 acres or less in size, the cost of suppression, number of men used, and man hours worked were very much out of proportion compared to the same items for larger fires. This is especially true when a comparison is made on an annual percentage

TABLE 2

OCCURRENCE OF FOREST FIRES BY MONTHS IN CENTRAL MASSACHUSETTS, AVERAGE PER YEAR, 1926-1928, INCLUSIVE

Month	Number of fires		Area burned		Damage[a]		Suppression cost	
	Number	Per cent	Acres	Per cent	Dollars	Per cent	Dollars	Per cent
March	74	9.1	574	4.4	2,896	2.9	682	3.2
April	447	54.9	8,165	62.8	75,077	74.2	11,858	56.9
May	215	26.5	3,951	30.3	21,047	20.7	7,190	34.5
June	24	2.9	85	0.6	567	0.6	383	1.8
July	23	2.8	158	1.2	1,372	1.4	363	1.7
August	3	0.4	11	0.1	90	0.1	59	0.3
September	4	0.5	15	0.1	128	0.1	111	0.5
October	9	1.1	27	0.2	30	....	105	0.5
November	15	1.8	40	0.3	22	....	115	0.6
Total	814	100.0	13,026	100.0	101,229	100.0	20,866	100.0

[a] Includes damage to buildings, fences, etc., as well as to trees, logs, cordwood, and lumber.

TABLE 3

FOREST FIRES IN CENTRAL MASSACHUSETTS BY AREA CLASSES, AVERAGE PER YEAR, 1926-1928, INCLUSIVE

Area class acres	Number of fires		Area burned			Damage				Suppression cost			
	Number	Per cent	Acres	Per cent	Per fire acres	Dollars	Per cent	Per fire dollars	Per acre dollars	Dollars	Per cent	Per fire dollars	Per acre dollars
Below .5	112	13.8	28	0.2	0.2	487	0.5	4.3	17.4	615	2.9	5.5	22.0
.5– .9	92	11.4	48	1.1	0.5	600	0.6	6.5	12.5	446	2.1	4.8	9.3
1– 5	415	51.0	1,021	7.7	2.5	8,056	8.0	19.4	7.9	4,180	20.0	10.1	4.1
6– 10	64	7.9	509	3.9	8.0	4,522	4.5	70.6	8.9	1,675	8.0	26.2	3.3
11– 25	57	7.0	1,019	7.7	18.0	7,993	7.9	140.2	7.8	2,218	10.6	38.9	2.2
26– 50	33	4.0	1,312	10.0	39.8	6,008	5.9	182.1	4.6	2,895	14.0	87.7	2.2
51– 75	11	1.4	759	5.8	69.0	3,387	3.3	307.9	4.5	755	3.6	68.8	1.0
76–100	10	1.2	987	7.6	98.7	6,121	6.0	612.1	6.2	1,076	5.2	107.6	1.8
101–200	11	1.4	1,688	12.9	153.4	9,416	9.3	856.0	5.6	2,140	10.2	194.5	1.3
201–300	4	0.5	1,021	7.7	255.2	4,722	4.7	1,180.5	4.6	849	4.1	212.2	0.8
301–400	2	0.2	726	5.6	363.0	3,418	3.4	1,709.0	4.7	692	3.3	346.0	0.9
401–500	1	0.1	477	3.6	477.0	3,970	3.9	397.0	8.3	328	1.6	328.0	0.7
Over 500	2	0.2	3,431	26.2	1,715.5	42,529	42.0	21,264.5	12.4	2,997	14.4	1,498.5	0.9
Total	814	100.0	13,026	100.0		101,229	100.0			20,866	100.0		

TABLE 3—*Continued*

Area class acres	Men used				Man hours worked			
	Number	Per cent	Number per fire	Number per acre	Number	Per cent	Number per fire	Number per acre
Below .5	714	6.7	6.4	25.5	876	2.4	7.8	31.3
.5- .9	577	5.4	6.3	12.0	758	2.1	8.2	15.8
1- 5	3,917	37.0	9.4	3.8	7,102	20.1	17.1	7.0
6- 10	906	8.6	14.2	1.8	2,265	6.4	35.4	4.4
11- 25	1,106	10.4	19.4	1.1	3,675	10.3	64.5	3.6
26- 50	1,097	10.4	33.2	0.8	4,008	11.3	121.4	3.0
51- 75	280	2.6	25.4	0.4	1,549	4.4	140.8	2.0
76-100	432	4.1	43.2	0.4	2,351	6.6	235.1	2.4
101-200	696	6.6	63.3	0.4	3,284	9.2	298.5	1.9
201-300	336	3.2	84.0	0.3	2,269	6.4	566.8	2.2
301-400	153	1.4	76.5	0.2	1,301	3.6	650.5	1.8
401-500	82	0.8	82.0	0.2	673	1.9	673.0	1.4
Over 500	300	2.8	150.0	0.9	5,457	15.3	2,728.5	1.6
Total	10,596	100.0			35,568	100.0		

basis. Thus, 20 per cent of the suppression costs, 37 per cent of the number of men used, and 20 per cent of the man hours worked were included in fighting fires in the 1 to 5 acre class. For fires 76-100 acres in size—whose average area burned by per cent was practically the same as that of the 1 to 5-acre class, and yet whose average size per fire was about forty times greater—the annual percentages were as follows: suppression costs 5.2 per cent, number of men used 4.1 per cent, and man hours worked 6.6 per cent. These data may be interpreted in one of two ways: First, that the forest fire wardens failed to secure sufficient men when fighting the larger fires and thereby allowed the larger fires to increase still further in size before finally extinguishing them; or secondly, that the wardens called out more men than were really required for the smaller fires but thereby prevented these smaller fires from becoming larger.

The direct economic loss to property caused by forest fires is recognized and appreciated by everyone. As far as is known, no one hithertofore has pointed out the indirect economic loss in man power. Thus, the annual average number of man hours used to suppress fires in central Massachusetts during 1926-1928, inclusive, was 35,568. Converted into man years (on the basis of 2205 man hours to a man year), this means that annually a total of 16 man years was lost to the community at large as the result of human carelessness.

REVIEWS

Agricultural Education in the United States. By Whitney H. Shepardson. *Pp. 132. The Macmillan Company, New York, 1929.*

The Rôle of Research in the Development of Forestry in North America. By I. W. Bailey, Bussey Institution for Research in Applied Biology, Harvard University, and H. A. Spoehr, Division of Plant Biology, Carnegie Institution of Washington. *Pp. 118. The Macmillan Company, New York, 1929.*

Until recently the General Education Board has given considerable thought to and funds for the promotion of research and education in medicine, physics, and chemistry, but little or none to biological sciences. Within the last few years, however, biological sciences also, and particularly agriculture and forestry, have begun to claim the attention of the Board. The two little volumes under review are the outcome of the Board's interest in these applied sciences. The report on forestry was made to the National Academy of Sciences, yet it was financed by the General Education Board, while the report on agriculture was made directly to the Board itself.

The two reports may be considered as companion volumes in spite of the apparent differences in the method of approach and in the object of investigation. The report on agricultural education was made in the hope that "it might provide some suggestions as to the more important needs of agricultural education and the way in which foundation funds might help to meet them." The investigation on forestry presents "a critical inquiry into the status and needs of research in the sciences basic to forestry." One, with agricultural education as a starting point, delves at length into fundamental biological research as a necessary corrollary to a high level of agricultural education. The other, having research as its principal objective, dwells a good deal on forest education as a means for the promotion of research. Although their starting points are different, in the end they cover about the same ground.

Even admitting the difference between agriculture and forestry as economic pursuits, a difference which Bailey and Spoehr point out, the two investigations accept plant physiology, ultimately resolved into physics and chemistry, as the underlying biological science of both agriculture and forestry. As a matter of fact, Shepardson quotes extensively from Bailey and Spoehr's report to prove his thesis and accepts their distinction between observational and basic experimental biological research.

Shepardson's report represents the reaction of a layman toward the *business of science*. It is written in extremely simple, delightful English, not without a touch of humor here and there, with perfect frankness, sympathy, and sincerity. Bailey and Spoehr's report has

a touch of the usual ponderous, scientific argumentation, with the occasional repetition and overlapping characteristic of double authorship.

It is significant that these two investigations come to fairly different conclusions. Shepardson sees in the existing agricultural colleges connected with our state universities the logical centers for the conduct of research in biological sciences underlying agriculture and for training high grade specialists. As a matter of fact, in his opinion, the two are interdependent, and research of fundamental character in agricultural colleges is an essential condition for training high grade men. Bailey and Spoehr, on the other hand, believe that research in the basic aspects of forestry cannot be developed and handled properly by the existing agencies—forest experiment stations, forest schools at the universities, and state forest departments. The investigators, as a result of their extensive studies, have been forced to the conclusion that the task of initiating, developing, and guiding researches in the more basic aspects of forest production should be entrusted to some special research institute, or to several smaller research institutes. These are to be located in university centers and affiliated more or less informally with the existing scientific departments.

There is a very incisive and illuminating discussion of the reasons why universities and the forest experiment stations cannot perform this task adequately: the pressing demand in these institutions for practical results and modes of immediate action; the pressure exerted by economic and political exigencies; the lack of assurance of a stable and continuing policy; the general tendency for science at the universities to dissociate into increasingly numerous subdivisions, each with its own particular interests, aims, and points of view; the traditional individualistic nature in universities inhibiting the development of an atmosphere of mutually beneficial coöperative relations in research; differences of opinion within a university regarding its function, and a certain competition between the purely pedagogic and research interests; political influences to which state institutions are subject from various sources; all these and many other conditions, in the opinion of the authors, militate against possible advancement of the basic biological sciences at the universities, forest schools, and forest experiment stations.

The authors, on the other hand, do not close their eyes to the shortcomings of certain types of separate research institutes, organized to promote research. What they propose is not the creation of a single large, isolated research institute, aloof from the scientific activities of other organizations, but rather the development of an independent research unit, ultimately of several smaller research units, which would be in close contact with the scientific activities at the universities, with the investigations conducted at the forest experiment stations and forest schools. These research institutes would guide the activities of other agencies without coercing them, and would carry on such activities as the existing agencies are incapable of performing but for which there is fundamental need; they would serve in the capacity of counselors and assist in perfecting instruments and methods; they would further offer facilities for workers from other forestry institutions to spend

time in obtaining intensive training and to pursue researches in the basic sciences on special aspects of forestry problems. In a word, the institute would constitute the highest scientific tribunal in matters pertaining to basic forest research but would pass on its findings to other scientific agencies, through suggestions, counsel, example, and probably financial assistance. The usefulness of such an institute must manifestly depend entirely on the voluntary coöperation between it and other scientific agencies.

Anyone who is not obsessed by narrow pride in the particular institution with which he may be connected will admit that Bailey and Spoehr's analysis of the situation is both keen and truthful. It is, of course, unfair to assume that the conditions pictured by the authors prevail generally at *all* universities and at *all* experiment stations. There are undoubtedly exceptions here and there. They exist, however, in a sufficiently large number of our universities and experiment stations to be fairly typical. If research in basic experimental sciences were the only and chief object, then the remedy suggested by Bailey and Spoehr should prove helpful. Of course, it is a new departure and must be considered at first in the nature of an experiment.

The fact that there is so much dissatisfaction with the slow progress of fundamental research in the universities is symptomatic of the existence of some unfavorable conditions for such development. The creation of an institute or institutes of the type described by the authors may be the answer, unless there is something in the whole atmosphere of our American life that inhibits and discourages fundamental research. The reward of such research is in the enjoyment of doing it, without regard to popular acclaim or personal advancement. The men attached to the new institute will undoubtedly be of the same type as is now engaged in scientific pursuit in our universities, forest schools, and forest experiment stations. If the same psychology pervades the new institute, what guarantee is there that the skillful self-advertising scientist, the one who can attract popular attention, the spectacular performer, will not be exalted, while the retiring researcher, who really digs deep but does not catch the popular imagination, will not continue to play a more or less obscure part, as he does now at many seats of learning?

Assuming, however, that the plan is workable, how much nearer does it bring us to actual practice of forestry in the woods?

Of course, anything that helps to advance the science of forestry will necessarily raise the level of our forest education. This, in turn, should result in better trained foresters. If the lack of knowledge of the proper handling of our forests were the chief cause of their disappearance, such a research institute in forestry would be of direct and immediate help. The truth of the matter, however, is that even the little knowledge we now possess is far in advance of its possible application. The tragedy of the forester in this country, particularly the one who is technically well trained, is that he is in the position of the person who is all spruced up and has no place to go.

The state of productivity of the forests in such European countries as France, Germany, Czechoslovakia, and Sweden is very high. Yet, they have no forest research institutes of the type

Bailey and Spoehr propose. It is true that most of them have forest experiment stations. These, however, are as a general rule connected with forest schools, and their value is chiefly educational. They are engaged largely in *post-hoc* examinations—in explaining or finding the reasons why this or that method succeeds better than another. But they themselves have very little influence upon the actual forest practice as it has developed. France and Sweden are particularly good examples of that. France has not even a forest experiment station, although she has highly competent foresters, and the French forests are in a very high state of productivity. In Sweden forest practice existed for centuries before the establishment of the forest experiment station, and according to Dr. Hesselmann, one of the leading lights in the Swedish forest experiment station, its effect upon the actual practice is still very insignificant.

Looking far ahead into the dim future, we can readily concede that the forest research institute should help to perfect our forest practice, but I am afraid it does not offer an immediate, direct answer to the problem of our vanishing forests. The answer most likely lies outside the scope of the limited inquiry. It most likely lies in the realm of legislation and economics. It may lie in the establishment all over the country of demonstration forests, similar to the ones which the Charles Lathrop Pack Foundation is now creating. These afford concrete visual examples of what forest practice can do. It does lie in just the type of empirical and observational studies as are carried on by our forest experiment stations and forest schools. It lies in the immediate training of better forest practitioners. The fellowships, therefore, recently made available in the field of forestry, it seems to me, are a step in the right direction.

In 1896 the National Academy of Sciences presented a specific and concrete plan for saving the forests of the country through setting aside part of the forested public domain as forest reserves. This recommendation proved of tremendous historic and practical significance. That recommendation was an answer to a very urgent and immediate problem of that day. Today, again, the National Academy of Sciences, true to its devotion to the best interests of the country, is presenting a further plan for the saving of the remaining forests and the rehabilitation of the cut-over forest land. Let us throw away our doubts, and hope that this new recommendation may prove as effective and far-reaching as the one made some 33 years ago.

RAPHAEL ZON.

The Rôle of Research in the Development of Forestry in North America. By I. W. Bailey and H. A. Spoehr. *Pp. 118. The Macmillan Company. 1929.*

This book is brief, well phrased, and easily read. The subject of discussion is timely and of great interest. In spite of an unscientific attitude, it is a valuable contribution to forestry literature and should serve to develop a better understanding of research in forestry.

The title of the work is a misnomer, both as to subject and locality, since the discussion is of silviculture only and is limited to the United States. This book is so concise that its meaning is frequently

obscure. Many conclusions are stated without intimation of how the authors arrived at them. The authors made an extended survey of forestry research here and abroad. With this in mind, the reader expects full discussion accompanied by citation and analysis of facts. There is a notable deficiency in this respect.

The solution of the forest research problem as seen by the authors is as follows:

"It is evident that the more intensive lines of descriptive and empirical research in the general field of forest production must be initiated and developed by the federal government and by educational institutions. . . . . On the one hand, the fact that immediate modes of procedure are of the greatest urgency and, on the other, that any truly fundamental attack on the problems of forestry entails, first of all, the accumulation of much information of a basic nature involving very extended periods of time, lead to the conclusion that two distinct types of research are essential. . . . . The dissemination of information gained from experience and investigations and the guiding of the policy of owners of many types of forest tracts by the federal and state forestry agencies, constitutes a public service which can hardly be overestimated. This is, in fact, the direct function and responsibility of these agencies. . . . . The federal and state forest services, forest schools and industries do not offer the medium for comprehensive programs of research in those phases of the basic experimental sciences, upon which the art of forest production must ultimately rest. . . . .

"The writers have, therefore, been forced to the conclusion that in the long run the interests both of forestry and of educational institutions can be served best if the task of initiating, developing and guiding researches in the more basic experimental aspects of forest production is assumed by some special administration agency. . . . . This institution should function not only as a central administration for funds contributed for the special purpose of furthering researches in the basic experimental aspects of forestry, but as an indispensable correlating and coördinating agent in the disbursement of such resources. . . . . These activities should not involve the creation of a single, large, isolated research institute but rather the development ultimately of several smaller research units which should be located in university centers and affiliated more or less informally with existing scientific departments. . . . . Correlations must also be established ultimately with the descriptive and empirical investigations in forestry conducted by federal educational and other agencies."

An endowed institute for conducting fundamental forest research will be most welcome. The need for basic research in the wide and complex field of forestry is so great that such an institute would be exceedingly helpful. However, before endorsing the plan outlined by the authors of this book, several questions regarding forest research should be more completely answered.

Can small, scattered research units render as effective service as a single large group of specialists whose efforts can be more closely coördinated and directed? If the state and federal agricultural experiment stations are able to do a steadily increasing amount of fundamental research, why is it impossible for the state and federal forest experiment stations to do a considerable amount of basic research? If the forest experiment stations are expected to do some fundamental research, will it be directed by the central administrative agency of the institute? If so, does the proposed plan

give assurance that this administrative agency will have the necessary forestry viewpoint? From the forestry viewpoint, can research be limited to forest production alone, uncorrelated with forest utilization (including forest economics and forest influences)?

If the authors' views are correctly understood, the province of the proposed institute is to solve general problems of an absolutely fundamental nature. For such problems, it appears advisable to organize a single large research group, well coördinated both within the group and with outside research agencies. Small, widely separated research units have an obvious advantage for regional studies but not for the kind of work the institute is expected to do. Centralizing the work of the institute would not prevent the conduct of research in the field when required, and would afford excellent opportunity for coöperating with regional research agencies.

It is difficult to agree with the authors in their opinion that the federal forest experiment stations are, by nature, unfitted for any fundamental research. The reasons for this opinion are little amplified beyond those given in the preceding quotations. If the forest experiment station organization is not now, in fact, the " research units " advocated by the authors, it would seem that complete discussion is in order.

Despite the authors' opinion to the contrary, there is good evidence that the public will adequately support the forest experiment stations in fundamental research as rapidly as those in charge can develop their programs and personnel to this end. The forest experiment stations have close contacts with the university centers, and if the personnel is inadequate to the task it is because research workers of the required training and experience are not now available. Any other forest research organization would be similarly handicapped at the present time.

The forest experiment stations are in their infancy but, even so, are they not doing more than empirical research? How do they differ from the agricultural experiment stations in relation to basic research? The function and operation of the agricultural experiment stations as compared with the forest stations should by all means be made clear. If the forest experiment stations are unfit for fundamental research, why are they unfit? These are major questions that are evaded by the unsupported statement that fundamental research cannot be done over long periods of time on public funds. State and federal forest experiment stations, and forest schools, should not be shut out from conducting fundamental research.

The authors claim, also, that fundamental differences exist between agriculture or forest utilization, and forest production, in working out and applying basic scientific research. Fundamental research should be conducted without regard to application and the authors evidently share this view, for they state: " Experimental research cannot remain within fixed boundaries; it should have every degree of freedom." The fact that there are differences in application does not change the essential character or needs of basic research in any of these lines. Research in forestry and agriculture is part of, and on the same plane as, other biological research.

The authors take the view that " future utilization of forest products is de-

pendent upon the growing of timber." This can be true only if there is a timber famine. Experience with other crops is that production depends upon utilization.

Under present industrial requirements, production of forest crops is a long and difficult process and forest utilization is highly inefficient. But the trend of developments in forest utilization is toward abolition of waste through conversion of forest and farm wastes into pulp and other cellulose products. This development when carried to its ultimate conclusion will make each acre yield several times its present volume of merchantable wood without any increase in growth. Furthermore, it will mean growing timber on short rotations, with great simplification in silvicultural practice. With the present development in science and invention it is certain that great changes in forest utilization will occur in the next two or three generations, and that such changes will profoundly effect forest production.

It is true at present, and apparently will be equally true in the future, that forestry is more a problem of efficient utilization than of production, although the two are inseparable. It seems unwise, however, to divide forestry into production and utilization, so far as fundamental research is concerned. Fundamental research is knowledge which cannot be shut up in water tight compartments, but is a free agent and has applications and values which cannot possibly be foreseen. For example, a study of the atomic structure of the cellulose molecule, now in progress, may show the way to convert wood into a far better and more economical structural material than lumber and thus revolutionize forest production requirements. At the same time such basic knowledge may have an equally important bearing on the means of securing growth which meets these new requirements.

It is readily appreciated that the authors limited discussion to silviculture because this branch of forestry is so urgently in need of basic research. But this does not alter the fact that all of forestry must be included in a discussion of the Rôle of Research in Forestry. Can a balanced plan for research in silviculture be developed except as a part of a complete plan of forestry research? In addition to utilization of wood produced by the forest, forestry and silviculture have fundamental relationships to wild life, public health and recreation, community development, streamflow, erosion, climate, etc., which are in need of basic research. For these reasons it seems impossible to effectively organize research in silviculture unless it is correlated with other basic forestry and biological research. Also the forestry viewpoint must be maintained in directing such work or it will not greatly improve our forestry conditions.

It is to be regretted that this treatise does not cover the whole field of forestry. It is also unfortunate that the authors fail to make fully clear the relationship of the proposed institute to the forest experiment stations and forest schools, assuming that it is not their intention to entirely shut these out of fundamental research. The creed of science is that facts rule, and in discussing scientific research it is highly desirable that facts be emphasized and opinions minimized.

S. B. Detwiler.

Relation of Forestry to the Control of Floods in the Mississippi Valley. Message from the President of the United States transmitting communications from the Secretary of Agriculture submitting reports with reference to the relation of forestry to the control of floods in the Mississippi Valley. *Document No. 573, House of Representatives, 70th Congress, 2d Session, Washington, 1929. Pp. vii+740, maps, figures, numerous tables.*

This document of 740 pages was prepared primarily by the Forest Service of the Department of Agriculture under the immediate direction of Associate Forester E. A. Sherman, who is to be congratulated on having brought together with systematic order between two covers an unwieldly mass of information pertinent to the problem of the control of Mississippi floods.

The document is a composite report. "Protection Forests of the Mississippi River Watershed and their Part in Flood Prevention" (pp. 1-51), by E. A. Sherman, is a summary report with recommendations. "Forest and Flood Relationships in the Mississippi Watershed" (pp. 53-84), by E. N. Munns, Chief, Office of Forest Experiment Stations, deals primarily with technical and scientific phases of the rôle of forests in water control. The remainder of the document (pp. 85-740) comprises six parts, describing conditions in the major river basins of the Mississippi, and 11 appendixes with miscellaneous pertinent information. Appendix I is the most important and includes for each of 73 drainage units detailed information on topography; geology and soils; climate; historical development; condition of lands other than forest; condition of forest; protective value of the watershed; character of cover; critical areas; and recommendations for the watershed.

As is indicated in the letter of transmittal to the President by the Secretary of Agriculture, the report indicates the need of still further detailed study of the factors involved; but it has brought to light facts which indicate that forests of the Mississippi watershed may be responsible for the reduction of flood crests as much as 15 inches, and further suggests that if all forest areas on the Mississippi were properly protected and managed a reduction of flood crests of 55 inches might be possible.

It is impossible in this review to indicate the nature of all the findings of fact for the individual watershed units, or even of the major regions into which the Mississippi watershed was divided for convenience of treatment. The reader who is interested in the problems of the Mississippi is urged to consult this important document which will stand as a significant contribution to literature on this subject. Consideration is therefore confined chiefly to the two summary reports.

Mr. Sherman's report, which had appeared previously in mimeographed form and as Circular No. 37, U. S. D. A., states that the Mississippi Valley prior to clearing and cultivation for agriculture was covered by forests to only 40 per cent of its area. One-half of the original forest area has been cleared for fields, leaving 20 per cent of the total area now in forests.

Floods on the Mississippi are recorded by the earliest explorers. In the past 209 years, since the first recorded flood, 52

notable floods have occurred with little indication of increased frequency. If the conversion of 20 per cent of forests into fields has not notably increased flood frequency, neither have the works of impounding waters by dams reduced flood frequency. Relative severity of floods is difficult to determine owing to increasing density of population and rising values of property subject to damage.

The starting point of the inquiry is given as "the self-evident fact that the condition of the land surface has a direct influence on the amount of water held and retained by the soil, on the time and rapidity of run-off and on the silt content of streams contributing to floods, as well as on the volume, velocity and turbidity of the water itself. It follows that any form of land use which affects the condition of the surface has a direct bearing on the run-off from that land."

The major features of the Mississippi catchment area are described and illustrated with maps. A discussion of principles involved in the relationship of forests to erosion and streamflow summarizes much of the reported results of investigations to be found in the literature. Special attention is given to the influence of the "mat of humus" of the forest floor. It is regretted that the word "humus" is used in place of the "litter" and "duff," which are standardized forestry terms and are more descriptive of the accumulation of leaves, twigs, and fruits on the forest floor.

The delimitation and description of critical areas constitutes one of the chief contributions of these series of reports. This method of treatment serves to direct attention to specific areas, where the problems may be met, studied, and solved in definite terms.

Erosion as a phase of the flood problem receives its proper emphasis in the discussion of flood control. Stress is laid on the lamentable lack of important data on the silt or sediment content of streams, which militates against a comprehensive and systematic plan of flood control.

Definite recommendations are made for measures which in no way are to replace levees, reservoirs, by-passes, or spillways, but to supplement them. Recommendations of special interest include (1) the extension of prevention and control of fire on forest lands; (2) the placing under forest of sub-marginal lands under the Clarke-McNary Act; (3) the purchase of about 2,642,000 acres of protection forest; (4) to make the control of erosion in the Badlands a special research project; (5) provision to establish permanent records of both streamflow and silt burden in the principal tributaries below Cairo, Ill.

Mr. Munns' report treats specifically of basic principles involved in the interrelationship between forest and soil and flood flows applicable to the Mississippi Valley. The relationship of forest areas is first shown to the concentration of heavy precipitation which is the primary cause of floods. The greater part of the forest area is shown to lie in the zone where the highest flood stages of the Mississippi originate. Whatever influences a forest may exert would be operative in this zone, roughly south of the 39th parallel.

Particular attention is given to the influence of forest litter on the control of precipitation waters, and findings of scientific studies are cited in numerous instances. Forest litter has been credited

with a controlling influence on water flow and erosion. This influence operates first as an absorbent of precipitation waters, as established by numerous determinations. On an average, forest litter has been found to absorb from 0.16 to 0.20 inches of rainfall. Forest litter accumulates rapidly under young plantations. The effect of reforestation is, therefore, soon exercised on streamflow.

In the second place forest litter maintains a mellowness of tilth in forest soils, which are therefore less compact than bare soils. Forest fires destroy forest litter and reduce the favorable effects ascribable to forest litter. Grazing by animals operates in the same direction as fire. Huffel is cited as inferring that the forest litter was responsible in restraining run-off from slopes under a rain of 2.4 to 2.8 inches. The manner in which the restraining influence was exercised is, however, not made clear by the author.

The reviewer's studies of forest litter on factors influencing the superficial run-off of rain are referred to as incomplete investigations by the California Forest Experiment Station. These studies were completed in January, 1929. The full significance of their findings is missed. The forest litter has been found to maintain the percolation or absorption capacity of a soil profile at its maximum under prolonged and heavy rains, beyond its point of saturation. In the final analysis the soil is the absorbent agent of the landscape; certain factors, such as the presence or absence of vegetation, and chiefly its layer of litter in intimate decompositional contact with mineral soil, will determine the rate of absorption of the soil profile. Thus Huffel's finding is explained not on the basis of saturation or resistance to surface run-off so much as the maintenance of absorption rates by the underlying soil to account for 2.8 inches of rain in one storm. It has become apparent that the remarkable capacity of forest litter to absorb water to 3 and 4 times its dry weight will account for only a small fraction of an inch of rainfall. In the heavy and prolonged falls of rain which are primarily responsible for the Mississippi floods the restraining influence of forest litter by absorption alone is short lived and actually plays a small part in flood control.

The maximum retention influence of a watershed is represented primarily by the maximum capacity for absorption by the soil and weathered rock above the water table. The rate of penetration is determined primarily by the conditions at the surface. Natural forest litter has been found by the reviewer to play a hitherto unsuspected and unappreciated part beyond the point of saturation in determining the rate of penetration of rain into the soil profile. The finer the texture of the soil the more striking is the comparative influence of forest litter. The coarser in texture soils are, the less is the influence of forest litter in this respect. This, in the judgment of the reviewer, more accurately represents the influence of the forest on water control.

The organic content of a soil is shown by the authors to increase the water-holding capacity, by weight. Also the effect of fires is to reduce the organic content and hence to reduce the water-holding capacity.

The forest with its floor of litter is shown to restrain surface erosion of for-

est soils. The manner in which this is done is not made clear. Removal of forests and destruction of litter accelerates erosion in high ratios.

Zon in his regional report calls attention to the large factor of transpiration, but its place in flood problems is not so clear. According to Sherman, a comparatively small part—15 to 20 per cent—of the total rainfall of the basin is found in the main stream as run-off or stream flow. How many times moisture is evaporated and reprecipitated in a watershed is indeterminate and the part which evaporated and transpired moisture plays in floods awaits solution.

The statement in the summary that the litter in a forest under silvicultural management should develop to become capable of absorbing at least 1 inch of water appears to the reviewer to be an inadequate appraisal of what actually takes place. In the first place, it is questioned if the forest litter in the average forest in the temperate region would account for so much rain water by absorption alone. On the other hand, the influence of the forest litter in maintaining the soil profile at its full capacity of absorption would be able to account not only for 1 inch but for 3 inches and even more beyond the bare condition of the same soil.

Foresters have been prone in their consideration of the forest to overlook the relative importance of the soil profile. Important findings have for this reason been misinterpreted. The two most important streamflow experiments which have thus far been made are not cited in this document. It is unfortunate that these important experiments should have been ignored. After a careful analysis, it appears to the reviewer that both the Emmenthal and Wagon Wheel Gap experiments have established two very important facts which need emphasis in the problem of flood control. The Emmenthal experiment demonstrated that a grass cover approaches a forest cover in maintaining the absorptive condition of the underlying soil profiles. The Wagon Wheel Gap experiment on the other hand demonstrated conclusively that the cutting of a forest, when it does not change the surface character of the soil profile, cannot be expected to change in an important way the absorptive capacity of the underlying soil profile. These are findings of primary importance in a comprehensive treatment of forest influences on water control.

Other factors enter into determining absorption or retention capacity of the soil sheath on a landscape, such as rising water tables in response to heavy and prolonged rains. This would nullify the favorable effect of the forest and its litter, under some conditions; thus the operation of these opposing factors requires analysis for each watershed to evaluate resultants in flood stages. It is, however, in the opinion of the reviewer safe to say that the natural mantle of forest vegetation, with its litter and the fauna which it feeds, accounts for far more than the inch of rain water taken as a conservative figure by the author.

Finally, the reviewer is impressed with the unfortunate situation brought about by departmental lines or otherwise which should call forth a report restricted to a single facet of approach to the problem of the control of flood waters on the Mississippi. The report is incomplete when measured by the scope of the

study as stated by Sherman and previously quoted in this review. The scope is land use and its influence on flood flows, but the report confines itself to the rôle of the forest, with a brief mention of the place of plowland in the problem.

It is plain that flood flows are resultants of precipitation and the retentive capacities of the total land surface of the watershed. Retention by the land is intended to include evaporation and transpiration, as affected by climate, vegetation, and cultivation, in addition to absorption. The soil mantle including weathered rock above water tables remains the principal agent of absorption of precipitation regardless of the covering of vegetation. The nature and condition of vegetative cover affect both the rate and capacity of absorption by the soil. The condition of soil profiles, therefore, requires first attention.

All land surface, including fields, pasture, and grazing lands, as well as forests, requires full consideration in a study of the factors affecting the concentration of flood waters. Forests play an important rôle in flood control; cultivated fields play a much greater rôle in a contrary direction. The report does not pursue the problem adequately in this direction. No other study has thus far done so. Full consideration should be given to factors which determine the retention and run-off from the agricultural regions. The treatment of farm lands may be shown to be as important as the treatment of non-agricultural lands.

The reports of individual watershed units have emphasized the importance of the effects of cultivation on erosion and run-off. Erosion, accelerated above the norm which existed prior to cultivation, is reflected in increased turbidity of streams. Silt content of streams becomes a sensitive index of the erosive processes at work in a watershed.

The control and disposal of flood stages in stream channels is primarily an engineering function. Measures of possible control through the retention capacity of the land surface involve a comprehensive study of the total land surface and an evaluation of all factors, and particularly of cultivation, grazing, and forests.

The document is a brief for the favorable influence of forests in flood control. No attempt is made to evaluate the various studies made in the past, results from some of which have been interpreted as minimizing favorable effects of forests. It was not within the province of this report to do so. Such an evaluation, however, is needed to clarify divergent views upon this important problem.

This report represents the composite work of many investigators, and supplies important information, first in stressing the need of further study and, second, in findings of fact adequate for constructive action by the Congress of the United States.

W. C. LOWDERMILK.

Plant Ecology. By John E. Weaver and Frederic E. Clements. *Pp. 520, Figs. 262. McGraw-Hill Publications in the Agricultural and Botanical Sciences. New York. 1929. $5.*

Those foresters who have not been too closely occupied running the business of the world, to follow the progress of

science as it pertains to tree growth, will be delighted to find in this new, comprehensive text, most, if not all, of the essential substance of Clements' previous works on general ecology, succession, plant indicators, etc., and of Weaver's numerous publications on root development and its ecological and practical significance. The book is fortified by a bibliography of 606 titles, and its "reading quality" and directness are greatly enhanced by the system of referring to the cited authors and their findings only by number. While there is a vast difference between a text and its supporting original scientific papers, this instance serves to show how great and how tiring are the ramblings, ruminations, and hesitations of most publications of the latter class, and how greatly scientific writing *might* be economized.

While this new book is probably all that might be desired as a general discussion of plant ecology, the reviewer feels certain that many foresters, and especially those who have known of Clements' opportunities for intimate contact with forestry and its problems, will be disappointed to discover that the lack of realism that has characterized all of the junior author's writing is persisted in. To be more specific, the problems of the natural reproduction of forests, are still in the author's mind problems of "aggregation, migration, and ecesis," and the reader finds not only that the references to forest reproduction are in the main so vague as to contain little that is helpful, but also that he must master a new and difficult vocabulary to comprehend even the general principles that are enunciated. Somewhat kinder things may be said of Weaver's discussion of the significance of roots, which "touches the earth" more frequently, although this work has been done very largely with agricultural and herbaceous plants rather than with trees.

But, in view of the difficulties experienced by the forest experiment stations in attaining to any investigations in "pure science," perhaps it is well that a few hardy spirits like Clements are able to keep their heads above the fogs of "practical necessity." The field still remains open to some one capable of translating sound science into terms useful to the forester.

The first seven chapters of the book treat of the origin and structure of vegetation and its units, of succession and its initial causes, of migration and establishment, competition and invasion. We then come, in Chapter VIII, to *Reaction and Stabilization,* under which, it seems to the reviewer, the reactions between vegetation and its habitat are treated more clearly and comprehensively than in any previous ecology. Reactions on and through the soil are strongly and properly stressed. It is believed that foresters will find this chapter especially helpful toward an understanding of the biological factors and changes which influence natural regeneration and succession in forests.

Chapters IX to XIII are given over to a discussion of factors of the habitat, 160 pages being devoted to this subject, and with greater elaboration than can possibly be justified except for elementary classes in ecology. We are somewhat surprised to find Weaver's contribution on "Relation of Underground Plant Parts to Environment" inserted immediately following the discussion of the soil, instead of being treated as a matter of "Adaptation," which does not

appear until Chapter XV is reached. Aside from this addition, and a somewhat greater emphasis on soil factors than characterized Clements' early "Ecology," we do not note any very material changes in the attitude toward environmental factors.

Chapter XVI and XVII deal with the relations between plants and animals, and with plant indicators, respectively. The latter, especially, will bear careful reading by foresters, and particularly by "grazing foresters."

We believe that the final chapter, which lists and discusses the climax formations of North America, will be found more helpful and enlightening to foresters than any other portion of the book. While the subject has been treated in various ways by other ecologists and foresters, we know of no one who has travelled so extensively or studied the country as a whole so thoroughly from this standpoint as Clements, and, needless to say, his "diagnosis" of the history, evolution, and relations of the different formations of the country improves with each rewriting. An understanding of the relations between the forests in different sections of the country and especially of the distinction between climaxes and sub-climaxes, should help any forester in comprehending the natural tendencies which he must aid or oppose in the treatment of his own local stands.

In conclusion, it may be said that the coalition between Weaver and Clements to produce a general ecology is a fortunate one. Weaver, as the senior author and presumably as the reviewer and compiler of Clements' previous works, has succeeded, by sufficiently stressing the soil as an ecological factor, in giving a better-balanced picture of ecology than the older writer has ever succeeded in doing.

C. G. Bates.

Colloidal Content and Related Soil Factors as Indicators of Site Quality. By I. T. Haig. *Yale University School of Forestry Bulletin No. 24. New Haven, 1929.*

In 9- to 26-year-old red pine plantations, on previously cultivated or pastured land in southern Connecticut, comparisons were made of site index and the following factors: (1) colloidal content of three soil horizons; (2) acidity, content of organic matter, and silt-plus-clay content of the top soil; (3) soil type; and (4) soil class. Data were secured from 95 points representing 22 different localities.

Site index was derived from height measurements and expressed in feet at 10 years of age; the colloidal and silt-plus-clay content being determined by Bouyoucos' hydrometer method. The soil horizons distinguished were A, usually 6 inches to 8 inches thick; B, from 6 inches to 30 inches deep; and C, usually below 30 inches.

The association of site index with measured soil data appears, from the scatter diagrams given, to be practically none for pH and slight for the other data. Of the computed correlation indices, 0.58 is the highest obtained for a single factor (silt-plus-clay content of the A layer). The colloidal content plus organic matter plus soil reaction of the A layers gave 0.65. Soil type and soil class, or even soil class alone, appeared as better measures of site quality, permit-

ting an estimate of site index with a smaller error than any of the measured data, alone or taken together. The author recommends soil class "as an excellent, quickly obtained measure of site quality of the soil." An intermediate soil class, the "very fine sandy loam," is the one which has shown the highest production.

Leaving aside all statistics, Haig's essential positive findings seem to be that two localities on coarse sand exhibited distinctly lower, and two on more or less sandy loam notably higher, growth than the average. The rest of the material hardly shows noteworthy correlation between site index and either soil class or measured content of fine material, although this remaining material represents 18 localities (out of 22) and 79 sets of observations (out of 95) and the silt-plus-clay content of the A horizon extends over a range of about 20 per cent to 60 per cent. Especially to be noted is the predominant influence, in all the correlations found, of one single locality—the five plantations "in one small area" on Merrimac sand. The demonstration would have gained in strength if more sandy localities could have been included or at least data given on the individual localities to prove their being fully comparable, as far as can be judged, in other respects than soil texture. It would seem to the reviewer that the work put in on statistics could have been used to greater advantage in trying to determine which of the localities had been cultivated and which only pastured; in distinguishing the different strata in the A horizon; in recording morphological data on the humus layer; and in giving particulars on the topography and some idea of the groundwater conditions—all points of first importance.

The rôle of soil texture as a site-determining factor has often been noted. Its not showing up better in the present work might be due to the investigation's dealing exclusively with red pine, which is known to be able to do remarkably well on poor and sandy as well as on better soils and thus it appears to be relatively little concerned with soil texture *per se*.

L. G. Romell.

Kort redegörelse för vissa skogliga försök, verkställda uder åren 1914-1928 å Kramfors Aktiebolags skogar, och resultatens praktiska tillämpning i skogsbruket. (Short report of certain forestry experiments carried out during the years 1914-1928 on Kramfors Co. forests, and the practical application of the results in forest practice.) By Erik W. Ronge. *Norrlands Skogsvårdsförbunds Tidskrift,* No. IV. 27 fig. 1928.

This is the first comprehensive publication of the results of Jägmästare Ronge's work, some phases of which were touched upon by the present reviewer in a previous note in the Journal of Forestry.[1] As such, this paper represents an important contribution to the literature of so-called industrial forestry—it describes the foundations, the result of years of investigation, of the forestry practice of one of the largest and most progressive pulp and paper and

[1] Baldwin, H. I. 1927. A Bolshevist Vindicated. Jour. For. 25: 893-897. (Incorrectly listed as a review.)

lumber companies in northern Sweden, and outlines briefly the present logging practice. Therefore one may be justified in describing the contents more in detail.

The chief question facing the company when it began placing its holdings under forest management some 15 years ago was what to do with the poor, slow-growing stands containing little merchantable timber. These formed a considerable percentage of the lands owned. Why was the growth so slow in this region? What were the basic environmental factors affecting growth, and how might they be altered so as to accelerate the rate of growth? These and other problems must be solved were the lands to be worth holding.

Northern Sweden lies between two great climatic influences, the warm Gulf stream with its influence toward a maritime climate, and Siberia with its extreme continental characteristics. While the first tempers the winters, the continental high pressure to the eastward makes the springs cool and helps to prolong wintry weather late into May. At the same time the insolation received in this latitude (64° N.) in spring is particularly strong and of long diurnal duration.

Investigations were made of the length of the vegetation period, the results of which were included in a publication by Romell.[2] Height growth in pine took place during 45 days from June 1 until July 15; spruce grew for about the same time, but a little later. Incidentally these dates coincide almost exactly with results obtained for white pine and red spruce in northern New Hampshire and Maine during the same years. For the beginning and end of height growth were taken the dates when 5 per cent and 95 per cent respectively of the seasonal growth had been completed. Measurement of the course of diameter growth, also described by Romell (*loc. cit.*), showed that this began only slightly earlier than height growth, and occupied about 60 to 65 days. The culmination of all growth (except height growth in spruce) occurred about June 10-20.

A most interesting phenological observation was the following: Height growth in pine began when birch buds began to burst, before other growth began; when the birch leaves began to appear, and were still less than 2 cm. in length, diameter growth began, attaining a maximum in 10 to 12 days. About this time spruce buds began to open. Again, when birch leaves began to yellow in the fall, diameter growth of the conifers ceased. Hence the outward appearance of the birch foliage was found to be a fairly good indicator of growth in the other trees.

Having investigated the effect of climate on the above-ground parts of the trees, Ronge next turned his attention to the soil, and followed the course of temperature there; or rather, both investigations were carried on simultaneously over many years, and in fact are still being continued. When it is realized that only a few hundred miles north of the tract in question, or a few hundred feet higher in the mountains, year-round frozen tundra is to be found, it is not surprising that soil temperature in these forests was found to be low—

[2] Romell, Lars-Gunnar. 1925. Växttidsundersökningar å tall och gran. Meddelanden från Statens Skogsförsöksanstalt, H. 22, No. 2. Reviewed by H. I. Baldwin in Jour. For. 23: 833-834. 1925.

especially in dense thickets of spruce which had come up after fire and often contained 20,000 to 30,000 stems per hectare (8000 to 12,000 per acre), few of them larger than 2 inches D. B. H. and 15 to 20 feet high, yet 100 to 130 years old. Here snow was prevented from accumulating on the ground to a sufficient depth to form a protective blanket for the soil because of interception by the dense crown canopy. The latter also interfered with rapid melting in the spring. By probing the ground with a steel rod, frost was found to form to a much greater depth in these thickets than in open stands, and—what was more important—did not disappear completely until nearly August 1. Then the vegetative period was practically over, and since the trees had not adapted themselves to a later vegetative period (recent researches point to photoperiodic control of growth responses), they were able to do little more than keep alive.

Foresters have been able to influence the climate of the atmosphere above ground but little by silvicultural measures, but Ronge was able to bring about profound changes in the soil climate by very heavy thinnings. After thinning, frost formed to but a fraction of the depth observed in untouched stands; snow built up a much deeper mantle, and in the spring melted snow water soaked into the soil in time to feed the roots during the spring drought when both height and diameter growth were at a maximum. Frost disappeared from the soil almost at once after the melting of the snow, and before the start of growth. A temperature of 5° C.[3] at 10 cm. depth in the soil occurred on June 5 in the thinned stands, but not until a month later on the control areas.

That these trees could live and grow at all depended on their root system. An examination of many trees disclosed that the living roots consisted chiefly of small roots sent out from the root collar, or base of the trunk. These lay only in the upper raw humus layer, which was warmed sufficiently by surface air blowing under the trees to allow the roots to function. Deeper roots were practically lifeless, and represented older roots which had been covered by accumulating raw humus until they approached the frost line. In thinned stands all living roots could begin functioning at the beginning of the vegetative period. Raw humus began to decompose after opening the stand. While most striking as a limiting factor in the extreme cases of spruce thickets, the question of soil temperature was found to be important also in other forest types, and formed thus a criterion for silvicultural treatment. As the soil temperature indicated, the canopy should be opened more or less and sun and snow let in on the soil.

The practical application of the principle of bettering the soil climate in the forest as far as possible, without failing to utilize the capacities of the site fully, was the large-scale employment of heavy thinnings. Instructions were sent to the company's local managers, outlining the degree of thinning to be made. In these the figures were intended only as a guide, it being understood that in certain cases wide deviations would be necessary. The definitions of the various classes of thinnings were roughly as follows:

1. *Thinnings.* Silvicultural operations yielding merchantable timber; the cost of

[3] This may be compared with a soil temperature of 10° C. (50° F.) observed in northwestern Maine in 1925. Before this temperature was reached no growth occurred.

the operation covered, or more than covered, by the value of the product removed.

a. Final thinning, after which the final cutting is to take place—about 15 years later. This thinning to be applied to normal stands, 80 to 100 years old, or to even older stands of similar stage of development, if it is believed they will react to the thinning. Approximate distance between trees: 4.5 to 5.5 m. (15 to 18 feet), or 500 to 350 trees per hectare (200 to 140 per acre).

b. Next-to-the-last thinning, at 65 to 80 years. Average spacing: 3.5 to 4.5 m. (11 to 15 feet), or 800 to 500 trees per hectare (320 to 200 per acre).

c. Next-to-next-to-the-last thinning, at 50 to 65 years. Average spacing: 2.5 to 3.5 m. (8 to 11 feet), or 1600 to 800 trees per hectare (640 to 320 per acre).

2. *Weedings.* Operations yielding no direct economic return, the cost of which is charged to silvicultural expense. These are applied to younger or older stands where density demands. In spruce stands trees should be left spaced at least 2.3 m. (8 feet), or about 1900 trees per hectare (760 per acre) when the height does not exceed 4 to 5 m. (13 to 17 feet). For greater heights, and for pine, a somewhat wider spacing should be used.

In 1928 alone, Kramfors Company weeded 5500 hectares (13,570 acres) at an average cost of 13.55 kronor per hectare ($1.34 per acre).

The results from sample plots thinned during the last 15 years show doubled and trebled growth, and higher actual production per hectare after 30 to 60 per cent of the volume had been removed. The mineral soils are of quite good quality, and can be made to give good yields under proper management. Wide periodic-growth trends due to climatic influences were found from a careful study made of the last 70 to 80 years' growth, but they were of much less magnitude than the growth changes caused by thinning, and do not refute the figures for actual greater growth and production on the thinned plots. During 1927 Prof. Tor Jonson and other experts checked the growth calculations.

In the actual marking and cutting of the thinnings the question of the practical carrying out of the work to the best advantage was not lost sight of. As a result of many experiments in driving and sawing logs of different types cut at different times of the year, the company now requires all pulpwood to be cut before August 1, so that it may dry out before driving; sawlogs are cut in the fall when danger of blueing is past, and are piled in open piles at the landings. Old growth trees are cut in winter and landed directly on the ice. As a result of this practice the sinkage per cent has not been over 0.8 per cent for the past nine years. In marking, only the wood to be cut at the time is marked, or if the trees to be cut in winter are few, they are designated by two spots, one over the other.

Ronge's report, of which the above is a very incomplete summary, should be of significance to American and Canadian forest owners as well as to neighboring companies in northern Sweden. It shows in detail how a wood-using industry, faced with the problem of making the best of rather poor lands, from which it must draw its timber, set about building its silvicultural practice on sound foundations from small-scale experiment. The principles once deter-

mined were applied fearlessly on a large scale. While other companies are still standing by and watching for the results, Kramfors is reaping the returns of increased growth on large areas.

A word as to the journal in which this paper appeared: The Association for Forest Conservation in Norrland, since changed to the Norrland Forestry Union, was founded in the early seventies and has since published two excellent forestry journals—one, "Skogsvännen" (The Forest Friend), founded in 1876, and the quarterly "Tidskrift" (not to be confused with "Skogsvårdsföreningens Tidskrift"), started in the nineties. Up to a few years ago, at least, to the reviewer's knowledge, neither of these excellent scientific journals were on file in the United States.

HENRY I. BALDWIN.

Lyctus Powderpost Beetles. By Ronald C. Fisher, officer in charge of entomology; with notes on (1) "Heat Sterilization of Timber in Relation to Kiln Seasoning," by S. T. C. Stillwell, officer in charge of seasoning, and (2) "Vessel Size and the Liability of Woods to Lyctus Attack," by S. H. Clarke, assistant wood technologist. *Bulletin No. 2, Forest Products Research, Department of Scientific and Industrial Research, Princes Risborough, Bucks, England. 1928.*

This paper, which is of interest to foresters and entomologists, resulted from an investigation of losses caused by insects to stored timber, with special reference to Lyctus powderpost beetles found mainly in imported American ash and oak lumber in the vicinity of High Wycombe and district and in a few timber ports.

The main part of the paper is concerned with the sterilization of infested timber by moist treatment, repeating and verifying the experiments conducted in this country,[1] and obtaining additional information to ascertain how far lower temperature and humidity, together with longer periods of treatment in sterilizing kilns, can be employed to destroy Lyctus beetles in all stages.

Part I furnishes information relative to the life history and habits, timbers attacked, economic importance, and control and remedial measures pertaining to the Lyctus powderpost beetles.

A study of larval habits confirmed previous views that such factors as temperature and condition of the timber and its nutritive value were important as affecting the rate of development of the brood. It was determined that the woods favorable for attack were those that were ring porous and diffuse porous, having numerous, large, open pores, as the larvæ had the habit of ovipositing in them. Clarke, after an extensive study of various woods, concluded that "pore size must be regarded as a limiting factor in the attacks of Lyctus."

It has been generally accepted that wood seasoned a year or more is in a condition favorable for Lyctus attack. It is of considerable interest, therefore, that Fisher has been able, under laboratory conditions, to infest small blocks of

[1] T. E. Snyder, and R. A. St. George. Determination of Temperatures Fatal to Powderpost Beetles, *Lyctus planicollis* LeConte, by steaming Infested Timber, Ash and Oak, in a Kiln. Jour. Agr. Res., 1924, Vol. 28, No. 10.

freshly cut oak with Lyctus beetles. In each of five experiments the adult beetles oviposited and the larvæ lived for several months in the wood. In no case did any of them survive to emerge as adults. This indicates to the reviewer that the wood was not in a condition favorable for their development and quite probably would not have been infested if other more favorable pieces had been present to allow a selection of the host. It appears quite probable that the beetles were forced into the block and that because of the small size of the samples enough change in the moisture condition of the wood may have occurred in the two to three weeks between the time of cutting and the time of caging to enable the larvæ to live for a certain period. When, however, conditions became too unfavorable the larvæ died.

As a result of this experiment, Fisher does not agree with Snyder's general statement[3] that "sapwood seasoned for less than 8 to 10 months will not be attacked," although apparently he overlooks the exception that Snyder made to cover thin stock attacked before this period because of more rapid seasoning.

The results of seasonal cutting experiments conducted by Dr. F. C. Craighead and the reviewer during 1918-1920 at the Eastern Field Station, East Falls Church, Virginia, showed that the degree of seasoning was an important factor in regard to the time of Lyctus attack. Ash, oak, and hickory poles were cut during every month in the year and were treated in various ways so as to produce different conditions of seasoning.

Small poles that were peeled as soon as cut and placed off of the ground in the sun, where they seasoned rapidly, were attacked much sooner than those treated similarly and placed in the shade. In some of the smaller pieces which seasoned most rapidly, Lyctus attack occurred in three to four months. Larger, thicker pieces that were not peeled were not attacked so readily.

Because of the foregoing conditions, the advisability of comparing the results of the two experiments, which were conducted under quite different conditions, that by Fisher in the laboratory and that by Snyder outdoors where natural selection was allowed, is questioned.

Fisher further points out that moisture is a very important factor in determining the degree of attack by Lyctus beetles. The results of three laboratory experiments indicated that wood was attacked with a moisture content of as much as 40 per cent and that the larvæ lived for a considerable period in samples where the moisture content varied from 28 to 10 per cent, but that no attack occurred in samples where it was less than 8 per cent. Fisher concluded, therefore, that a higher moisture content is more favorable for Lyctus than a low one.

Fisher also determined that if there is a further change, during the seasoning of wood, in the chemical composition of the cell content, this alone apparently does not determine whether or not it will be attacked by Lyctus. Again, in mentioning what might constitute the food of Lyctus larvæ, Fisher suggests that there may be a symbiotic relation between species of fungi and Lyctus beetles, in view of the recovery of a fungus, fairly near Phomopsis, by two independent investigators, one at the Im-

[3] T. E. Snyder. Preventing damage by Lyctus powderpost beetles. U. S. D. A. Farmers' Bull. 1477, p. 12.

perial Forestry Institute and the other at the Forest Products Research Laboratory.

In regard to the economic importance of Lyctus beetles in Britain, Fisher points out that the situation is very grave. Not only do these beetles injure or destroy furniture and aircraft stock and cause a general lowering of grade of important timbers of commerce, but their work is of great importance to the whole hardwood timber trade. He says further that "timber is placed on the market today which in past years would have been rejected, and in fact, an allowance has been made for the prevalence of 'worm in timber.'"

It is believed by English authorities, after extensive investigations, that this condition exists largely as the result of importations of infested lumber from America since the World War. They state that "the presence of Lyctus is either not suspected by the timber merchants (in the United States) handling the timber, or, if suspected, it is sold and passed on as quickly as possible." This results in the selling of infested material at a cheap rate. In one instance the sale affected a whole shipload of lumber. Fisher urges that some action should be taken to remedy the situation.

In the opinion of the reviewer, with the exportation of about 7 per cent (some 2,000,000,000 board feet) of our total lumber production, there is some danger of an unfavorable reaction upon the American markets if such action is taken by Great Britain because of the prevalence of Lyctus in our product.

There are four species involved, only one of which, *Lyctus linearis* Goeze, is a native of Europe. The most abundant species is *L. brunneus* Steph., which is now more abundant in England than the native species. Two other species, *L. parallelopipedus* Melsh. and *L. planicollis* LeConte, introduced from the eastern part of the United States, are gradually becoming established.

It appears to the reviewer that a remedy for this situation lies in keeping the oldest lumber moving first, in regular inspections (annual or semi-annual, if necessary) to sort out infested from non-infested stock, thereby preventing additional wood from being injured, and in kiln-drying the slightly infested lumber to check the damage within as specified below. It would also be advantageous to have a final inspection of the lumber intended for exportation just before it leaves the mills for shipment abroad.

Partially seasoned and seasoned stock in the rough, used in the manufacture of furniture, should be protected from Lyctus injury by the methods recommended by the Department in Farmers' Bulletin 1477.

It has been demonstrated, both in Europe and in this country, that Lyctus powderpost injury can be controlled, if not almost entirely eliminated, by adopting preventive and remedial measures that are now recommended and generally accepted by entomologists.

Fisher confirmed the experiments conducted in this country which demonstrated that Lyctus injury could be checked by the use of moist heat (live steam) where temperatures of 130° F. and upward are maintained for one and a half hours or longer, provided all parts of the infested wood have at the beginning of these temperatures been brought to the minimum temperature of 130° F. In repeating this experiment an addi-

tional allowance of one-half hour was made by Fisher with 1-inch boards to overcome any lag between the temperature of the atmosphere in the kiln and that in the wood. Another similar period was added as a safety factor. The experiment was broadened to determine the length of time necessary to expose infested lumber of various thicknesses in the kiln in order to obtain fatal temperatures. Fisher's schedule is as follows:

Thickness of timber Inches	Temperature required ° F.	Time required to overcome lag after kiln has attained 130° F. Hours	Additional safety factor Hours	Time held at 130° F. Hours	Total period in kiln at 130° F. Hours
1	130	½	½	1½	2½
2	130	2	½	1½	4
2½	130	3¼	½	1½	5¼
3	130	4½	½	1½	6½

The reviewer wishes to point out that heat sterilization, while effective in killing the broods of the beetle within the wood, does not render it immune from further attack. To accomplish this, Snyder recommends a thorough steaming of the wood for various periods at different pressures. Treating white ash boards with steam for from 10 to 20 hours at 28 pounds pressure, and for 17 hours at 45 pounds pressure, will make them immune from attack. The wood is rendered darker in color by steaming, and in certain cases this might be disadvantageous.

In the opinion of the reviewer, the adoption of the above suggestions would aid materially in checking Lyctus injury in this country and abroad, and would create a more favorable impression with regard to lumber imported from America by foreign markets.

R. A. St. George.

NOTES

Cellulose Forestry

Washington, D. C.,
August 13, 1929.

Mr. Alfred Gaskill,
Brandon, Vermont.

Dear Mr. Gaskill:

I have just read your intensely interesting article in the March issue of the Journal of Forestry, and I want to congratulate you on so clearly and forcefully presenting a problem which, if fully analyzed and followed through, should have a tremendous effect upon the future of forestry in the United States. I also congratulate the Journal on printing your article and thus opening up the possibility of thoroughly reviewing long-established silvicultural practice.

For the past 10 years, I have believed that the point of view of many foresters with reference to the future of their profession was badly distorted and your article indicates that you, at least, are breaking away from hidebound theories and practices which have established a silvicultural system that has been reluctant to change. However, it may be that your article will cause foresters to think a little beyond the rather narrow confines of their preconceived theories and if it does we may expect great things to grow out of what you have so ably started.

Just as an example of what your article has opened up: Having spent about 20 years in California, partly in the U. S. Forest Service and partly in the lumber industry, I have had an opportunity to see worked out in actual practice a silvicultural system based primarily upon the theory that future demand is going to be for lumber, and for lumber in large sizes and of high grade, produced from the so-called "best" species, that is, those species that now furnish lumber bringing the highest prices in the present market. By future demand I mean demand in, say, 50 to 100 years.

In the California pine region, that means first, sugar pine, and second, California white pine. White fir, incense cedar, and Douglas fir are not given even honorable mention in the program.

For many years the California silviculturists insisted upon so handling the cutting of the mature forest in the Sierra Nevada that sugar pine would be the future dominating species. Some still do, but there are a few who have finally succeeded in getting a considerable modification of this impossible policy.

Consider sugar pine for a moment. It bears seed prolifically only about once in seven years. Therefore, it cannot be depended upon to furnish adequate seed for natural reproduction. Furthermore, when a good seed year comes, squirrels gather in force and pretty well clean up the crop. If it escapes the squirrels and seedlings do become established, they are very susceptible to fire. After escaping fire, we are assured by the forest pathologists that pine blister rust is inevitable in the sugar pine stands unless more mil-

lions are spent in eradication than sugar pine lumber can possibly be worth by the wildest stretch of the imagination. It is apparent, therefore, that sugar pine is ultimately doomed as a permanent constituent of the California forests, yet effort is still being made at somebody's expense to establish it.

On the practical side, what are the facts? Sugar pine is noted for the wide, thick, clear, fine-textured boards which are produced from the present stand comprised of mature timber some 300 or more years of age. Surely no forester is optimistic enough to contemplate a 300-year rotation for sugar pine to produce this class of material. Somebody's money is tied up in it, either private or public, and it makes little difference which. Suppose it was handled on a 300-year rotation, what would be the value of the product at maturity?

The principal special uses for the large dimension, clear lumber, are patterns, templates, and drain boards. Within the past three years the foundries and other pattern makers have found that they can successfully use sugar pine selected *common* lumber at a greatly reduced cost. Wood drain boards are becoming about as extinct as the dodo. In other uses for clear lumber, sugar pine has little advantage over numerous other species. As a matter of fact, the public in the future will suffer little inconvenience if it has no clear lumber in large dimensions from any species with the possible exception of spruce airplane stock, a few other selected uses. When it comes to common lumber, sugar pine is in the same category with any number of other species, so why try to reproduce it against all the forces of disease, animal attack, fire, etc.? This is a question that has puzzled me for years and one which I have raised at every available opportunity. Your article will help in arriving at the answer. The merchantable sugar pine seed trees which the lumber industry was forced to leave for the purpose of reproducing future forests will, if they do not blow down in the meantime, or succumb to disease, bear future witness to a mistaken silvicultural policy for which the public naturally has to pay. Every dollar not taken out from a merchantable sugar pine seed tree is a dollar wasted.

Eliminating sugar pine and coming to California white pine, we have again a species which in 200 or 300 years will produce a large percentage of thick, wide, clear lumber of high grade. It has a little more shrinkage than sugar pine, is a trifle harder in texture, and is slightly heavier. However, selected lumber has been successfully used for patterns and templates and it makes satisfactory drain boards. No mention has been made of clear finish in either pine species. The reason is obvious. Tight-knotted common is now coming into vogue and if it remains the style, or does not, there is no particular hardship in its use. Clear boards will eventually be displaced by plywood anyway, on account of its ability to resist shrinkage and swelling and the fact that so much more value can be secured from a given log in the form of veneer.

The present generation of silviculturists in California is gradually placing more and more dependence for a future forest upon California white pine. It seeds prolifically every year and bears seed at an early age. The young trees are hardy and grow quite rapidly. This is certainly a step in the right direction

providing we assume that *lumber* is the prime objective.

What happens to the other species in the stand under this form of silviculture? The mature timber is destroyed in an attempt to prevent its crowding out the California white pine that has been selected on the ground of its superior lumber yield. White fir is particularly discriminated against, a species yielding lumber which, under present market conditions, cannot be manufactured at a profit. What is the result? I have known of recent cases where an operator on government stumpage has offered to pay the Forest Service *twice* the contract stumpage value of white fir if it could be allowed to stand in the forest. I know of instances where the operator agreed to pay for the white fir stumpage, fell the trees, and leave them in the woods, thus removing the risk of fire. Again I know of offers to pay for the timber, fell it, trim it, and pile and burn the brush. Yet to none of these offers would the silviculturist agree. The logs had to be transported to the mill, sawn into boards, and *then* the lumberman could burn them up if he so desired. Having incurred expense up to that point he naturally sold the white fir lumber for what he could get out of it and charged the balance to loss. Is this good silviculture on the basis of lumber alone? White fir lumber is far from being inferior, although it suffers from an inferiority complex partly because the market has been flooded with other woods of slightly higher quality at a not very much higher price. If every other species producing soft-textured lumber should be wiped out, white fir would come into its own as a perfectly satisfactory substitute for them all with no hardship to anybody.

How about the difficulty of establishing a future forest in which white fir predominates? You can't help it in spite of the best efforts of silviculturists to prevent it. It would be amusing, if not touched with irony, to observe the values wasted in a futile attempt to eradicate what will undoubtedly prove to be the very best species for future generations.

The argument against white fir for years was its generally unsound condition, and forest sanitation alone was considered sufficient to damn it. Now the forest pathologists step in and prove that decay will not touch a white fir under an age of about 70 years. Who among the silviculturists will step forward and recommend a rotation of much over 80 years? Old man interest alone will shove him off the stage.

I feel perfectly free to suggest to those holding the destinies of the publicly owned forests in California in their charge that they have overlooked the obvious fact that white fir will grow as great as or a greater volume of timber per acre per year on an 80-year rotation than any other species in its range.

I can hear somebody say, " Well, how about stumpage values on white fir as against the pines, 80 years hence? " My answer is, " Look at hemlock in the Lake States." On the other hand, the crowding in of substitutes for lumber today is a very serious problem. The annual cut of lumber has dropped from about 45 billion to about 30 billion board feet. With a per capita consumption corresponding to England, which is far from being a decadent nation, it is estimated that our present annual forest growth is sufficient to support 200 millions of population.

Another thing to think about: Assume that sugar pine stumpage today is worth $6 per 1000 feet in the tree and limestone in the ground 1 cent per ton. Carry these investments for a few years and see where it lands you. Stumpage is becoming more difficult to log as the nearby forests are cut out and it is necessary to get into rougher country. A higher initial cost per unit plus constantly increasing costs of getting timber out, with a lesser cost for obtaining substitute materials, means that as time goes on, the lumber industry will have a constantly harder fight to maintain a profitable operating margin. Therefore, starting with a relatively low-value species like white fir, the time of reckoning is postponed.

So much for lumber—now we arrive at a direct consideration of your paper.

Recently there gathered at a dinner four men: the first a director of great technical forest products laboratory, the second an industrial chemist in forest products, the third connected in an executive capacity with a prominent commercial research laboratory specializing in the use of wood wastes, the fourth for many years manager of one of the soft-pine manufacturers associations and in intimate touch with the marketing problems of this group.

These men had all spent many years in the U. S. Forest Service and two of them, at least, were foresters by training and experience. It is assumed that they all at one time subscribed to the belief of an impending timber famine and the necessity for doing something drastic about it.

Then, after 20 years' separation and constant contact with forest problems from widely divergent angles, they met and reviewed the forest situation at present confronting foresters, the lumber industry, and the public. The discussion was intensely interesting and the conclusions reached so at variance with the popular conception of the situation, that they are given as indicative of the viewpoint held by technical men in a position to analyze the problem through actual contact with it over a long period and throughout the United States:

1. The growing of trees to produce lumber, as that term is now defined, is not justified for the purpose of preventing a so-called lumber famine.

2. With rising costs of manufacture and enhancing stumpage values the lumber industry will have great difficulty in profitably retiring its present investments.

3. There are no uses for lumber in large dimensions for which substitute materials are not now available or can be made available as lumber supplies decrease or become more costly.

4. The only lumber or timber forest product for which research so far has failed to supply a reasonably satisfactory substitute is the common crosstie. This requires the growth of only pole size trees of practically any species due to the almost universal use of preservatives. It is assumed that future transportation is going to remain largely on rails, which would make a crosstie supply essential. Even this is a matter of dispute.

There is no evidence to prove that the second growth which is inevitable on forest lands throughout the country will not be ample to meet all crosstie requirements with a substantial surplus. The preservative treatment of ties is steadily reducing annual requirements in spite of increased trackage.

5. The immediate problem facing the lumber industry is not how to grow more trees, but rather how to secure the maxi-

mum utilization of those we now have; and this in turn requires forest products research to determine uses, and economic research to get the products used intelligently. The former is well under way. The latter is only beginning and upon it should be centered the thought of the government, the lumber industry, and the public.

6. The only *permanent* forest product of constantly increasing importance is *cellulose* which, in the form of fiber, is adapted to almost unlimited development.

As you state, this does not require large trees and in fact is not dependent upon the forests at all. However, at the present time and possibly for all time to come, rapidly growing forest trees on a short rotation will be the main source of cellulose.

I predict that it is but a relatively short time from the present practice to the time when boards, sash, frames, moulding, and in fact any desired finishing or factory shape, will for the most part be pressed out of pulp and in the process will be rendered practically waterproof, decayproof, and fireproof. This is largely a problem of cellulose chemistry and mechanics.

The public has little to worry about, but the lumber industry much.

Very sincerely yours,
C. Stowell Smith.

Washington, D. C.,
August 2, 1929.

Mr. Alfred Gaskill,
Brandon, Vermont.

My Dear Gaskill:

This week was my first opportunity to read your iconoclastic article, "Why Sawlogs?", in the March issue of the Journal. Your shot at the doctrine of an impending timber famine, of the necessity for a never-ending abundance of sawlogs, and of the pressing need to keep all of our 470 million acres of forest land at their full productivity of sawtimber, is a direct attack on the basic tenets of faith of the First Church of God and Forestry. With one and the same stroke of your facile pen you destroy all justification for mandatory legislation to force the wicked lumbermen to do the will of the United Brethren; you abolish the careful plans of the U. S. Forest Service to expand federal forest ownership into the level regions of the South and Lake States; and you make the laborious, painstaking silvicultural practices on the National Forests look as if they were front end backwards.

Concerning the last, by way of illustration, my mind reverts to the Sierra forests of California, from which I am recently come. There, acording to present official standards, sugar pine is by far the most valuable of all the species and is cut with extreme conservatism in order to increase its percentage in the future stand. White fir and incense cedar are worthless weeds to be eliminated by every means. The lumber sale contracts require the purchaser to cut and remove the white fir and cedar even though there is a net loss in doing so. This loss is offset by a theoretically proportionate reduction in stumpage prices of the sugar and pondosa pines. To accomplish its purpose the U. S. Forest Service is sacrificing present revenues, and, if your forecast is correct, is sacrificing future revenues also. If the demand of the future is to be for *volume* of *cellulose* and not size, form, or quality,

the question raises itself if present cutting practice should not aim to discourage the regrowth of the two pines and encourage increase in percentage of the fir and cedar, an end which could be much more cheaply attained.

The same question could be raised concerning the forests of northern Idaho, where large sacrifices in present revenue are being made to eliminate the hemlock and other "mixed" species in favor of the white pine.

As to the plans for broad expansion of federal forest ownership in the level regions, and the agitation for mandatory regulation, they are both based on the premise that our future timber needs require the maintenance in maximum productive condition of every last acre of our total forest area of 470 millions; that this need is so pressing as to justify the most radical measures.

Your theory obliterates this premise. In its place you give us the probability that our future commercial timber needs can be met from a much more limited acreage. This same probability, as you know, is concurred in by other thinkers in forest economics.

Among them, if you have not already read it, I commend to you the book entitled "What About the Year 2000?", recently published by the American Civic Association, Washington, D. C. It is a compilation of the best thought and opinion of our leading land economists on our future land needs. In discussing forest uses of land, it follows a different line of reasoning than you, but develops the same point of view, and foresees, therefore, no economic loss if some denuded forest areas are left barren.

The doctrine you have preached will, I fear, seriously disturb the mental peace of us old-time forest fundamentalists. We have lived and breathed so long in the atmosphere of an impending timber famine, and all its accompaniments, that it will take more than one swift jolt to arouse us to an acceptance of the new knowledge and understanding of the trend of things.

You remind me of the fellow who arose in the revival meeting to avow that there is no hell. If my memory serves me, he was thrown out on his ear, and later on certain states passed laws prohibiting evolution. Then the congregation arose and sang "The Old Time Religion is Good Enough for Me."

Sincerely yours,

F. W. Reed.

Comments on Hanzlik's Criticism of Yield Tables

In the March, 1929, issue of the Journal, pages 282-286, under the title "Some Comments on the Methods of Presenting Data in Yield Tables," E. J. Hanzlik compares a number of the more recent yield tables, and criticizes the lack of uniformity in presentation. In the following pages, a summary of each of Hanzlik's criticisms will be given (italics) followed by a discussion of the issues raised.

1. *The adoption of Graves' standard form for presentation of yield tables is suggested, in which a separate table for each site contains all the essential data, in preference to the newer form in which a separate table for each factor contains values for all ages and site indices.*

Present-day tables contain much more information than it was usual to include when Graves' form was prepared. The

additional information, especially when several limits of merchantability are provided for, cannot be readily arranged in Graves' form. The large number of site indices permits the presentation of factors separately, yet compactly, while the old tables, based on three site classes, would lack compactness, since similar separate tables would have only three columns.

2. *The need for reversion to Graves' form is supposedly shown by Meyer's revision of McArdle's Douglas fir yield tables.*

In Meyer's study of yield prediction for Douglas fir, only a small part of the yield table data was needed. The rearrangement was made merely to secure compactness in the abbreviated tables.

Meyer's complete yield tables for red spruce, white spruce, and balsam fir are presented in the new form—a separate table for each factor.

3. *Behre's western yellow pine yield table is only partially complete in its presentation of data.*

Behre specifically states that it is a preliminary table. As such, it cannot be condemned for incompleteness. In addition, its basis—83 small plots—does not warrant, nor would it permit, the preparation of exhaustive tables, which in themselves would imply a non-existent reliability.

Although but recently published, the data for these tables were collected some time ago, before the Society's committee on standardization of technique had been formed.

4. *The adoption of 100 years as the standard site classification age is urged, discarding the 50-year basis.*

The site classification age should be related, to some extent, to the rotation age of the species. If the rotation age were 75 years, a 100 years basis for site classification would not serve. The use of both 50 and 100 years should cause no confusion, since long and short rotation species would seldom be compared. A multiplicity of classification ages would be very inconvenient, but there should be no objection to having two standard ages. If necessary, tables can be converted easily from one basis to another.

5. *The practice of showing volumes by both the International ⅛-inch kerf and Scribner rules should be universal. International ¼-inch kerf should not be used.*

International rule values can be readily converted from one kerf-width basis to another by a flat percentage of either initial or final values.

The use of the Scribner rule is not universal, and Scribner values should therefore not be included in all tables. Where the local rule in the region to which the yield tables apply is not Scribner, the local rule should be used.

6. *Standard merchantability limits, both D.B.H. and top diameter, should be set up.*

Top diameters are adjusted to general conditions throughout the region to which the tables apply, and a difference of 1, 2, or even 3 inches (5 to 8-inch top) will not cause any appreciable difference in volumes of mature stands. It will affect the volume of *young* stands because of the number of trees considered merchantable. No fixed D.B.H. limit of merchantability should be set. This depends entirely on top diameter and the merchantability limit now in use—that no trees will be considered merchantable which will not cut one 16-foot log of the

specified top diameter. A fixed D.B.H. limit would penalize thin barked species.

7. *Tables giving dominant and codominant heights on age are of the greatest value. Average heights of all trees are of no value. McArdle uses dominant and codominant heights for site index; Schumacher, Behre, and Show use dominants.*

Average height of all trees is a factor properly belonging in a table relating to the entire stand. It is not very useful, but may be of value where the field data do not give dominant height or where poles are an important product. Dominant height is used chiefly for site classification and would be included in the dominant-stand table, if such is presented.

Show is right in using only dominants for site classification since his study is based on mature trees. Behre, however, states on page 381 of his article in the *Journal of Agricultural Research* that both dominant and codominant heights are used. Schumacher states that he followed Bruce's method, using a three-class crown classification, which means that his dominant group includes both dominant and codominant trees of the four-group classification.

8. *Behre gives the number of trees in the entire stand only, omitting similar values for the merchantable stand. The lower diameter limit differs for each study and a standard lower limit of 2 or 3 inches is recommended.*

Behre's table is not supposed to be complete: the basic data are insufficient for deriving such values accurately. An approximation of the number of trees for the merchantable stand could be derived from the stand tables.

Behre's 3-inch lower limit was used before the Society's standard procedure for yield tables came out, while McArdle's 2-inch limit was forced by previous work which took trees only down to 2 inches. Schumacher's practice of taking all trees which reach breast height is the best of the three.

A 2- or 3-inch lower diameter limit is not satisfactory since it complicates stand table construction by curtailing the frequency curves. Taking all trees, as Schumacher has, is the best practice.

9. *All tables give average diameter of entire stand but only McArdle gives average diameter of trees in merchantable stand. Schumacher derives his average by averaging tree diameters while the other three give the diameter of the tree of average basal area. Schumacher's average is simplest for the field man.*

The average diameter of the merchantable stand should be given. It also might be well to give average diameters derived both from diameter and by basal area. Total basal area, for determining normality, cannot be computed from number of trees and average diameter derived by averaging diameters directly.

10. *Set standards for presenting yield data seem to be lacking.*

Rigid standards will cause as much trouble as the variations discussed. The Society's "standard procedure" permits a certain amount of variation, which is necessary in view of the differences in practice between regions.

Much of the work referred to antedates the standard procedure.

11. *A table form is proposed for adoption as a standard.*

The form presented is bulky and hard to use. It is no easier to make comparisons than with the separate-table type.

The latter has the advantage of concentrating attention on one factor at a time. If it is desired to compare two or more factors throughout the life of the stand, it is highly desirable, with either type of table, to jot down the few desired figures, or to plot curves.

12. *The great differences in yield table forms indicate that a standard form is desirable.*

The newest tables, not yet printed, are quite standardized in form. Those for the four southern pines, southern white cedar, red and white spruce, balsam fir, and the western white pine type, will be similar in form to those of McArdle's Douglas fir.

In conclusion, the single factor table has the advantage of simplicity, permits easy interpolation between age and site index, concentrates attention on the factor under immediate consideration, and comparison between species, where values at various ages are compared, is easier with simple compact tables than with large multi-columnar tables.

L. H. Reineke.

International Congress of Forest Experiment Stations in Sweden

A detailed account of the two weeks' excursions and one week's meetings of the International Congress of Forest Experiment Stations in Sweden in July, 1929, would make a book of considerable size. The purpose here is merely to give some general impressions. It must also be realized that the aspects which are of most interest to one person are not necessarily those which most interest others.

The outstanding feature, I think everyone will agree, was the thorough preparation and admirable organization which resulted in supplying everyone with complete information beforehand and in running off the excursions so that practically every moment was utilized aside from that required in going from one point to another. A complete guide of the excursions, containing 94 pages of text, 49 tables, and 45 illustrations, was furnished each member. This was printed separately in three different languages, English, French, and German, and was so complete that note taking, except for occasional marginal comments, was almost unnecessary. In addition to this program, we were furnished with a bulletin of 87 pages on "The Experimental Forests of Kulbäcksliden and Svartberget in north Sweden," covering the geology and vegetation, with numerous illustrations and detailed maps of each forest—a valuable work on soils and ecological conditions.

Contact between the 141 members, representing 35 nationalities, was facilitated by a list, arranged by countries, in which was given a photograph of each member alongside of his name, position, and address. In addition, each member wore a badge with a number corresponding to his number in the list, rendering it very easy to identify anyone. While the main emphasis was upon silvics and silviculture, an opportunity was afforded to see the floating of logs down the rivers and the manufacture of lumber and paper.

The extreme southern end of Sweden contains limestone and fertile soils. While largely agricultural, there are forests of beech with a certain amount of oak, similar to those in north-central

Europe. Over the remainder of the country one is impressed by the uniformity of forest conditions, which contrast strongly with the variety one finds in the United States. One goes through mile after mile of forests of Scotch pine and spruce, the former predominant and in pure stands over large areas, the latter frequently in mixture, and, in north Sweden, predominant on the upland between the stream valleys.

The problem of inferior species which we have does not exist in Sweden. Pine is favored as bringing better prices than the spruce. The birch in mixture improves the soil, although this does not yet seem to be generally realized since in most of the forests which we saw the birch has been cut out. The network of drivable streams and the floatability of pine and spruce render transportation conditions extremely favorable. The maximum distance of any forest from a drivable stream is said to be about seven miles and the average distance less than two. With the excellent markets it is but natural that forestry should be profitable.

Anyone familiar with our northeastern spruce region notices the analogy, and is inclined to envy Sweden her stands of pure softwoods which do not have the problem of non-floatable hardwoods which we have in Maine; although it is possible that eventually, with a fully developed market and adequate transportation, our mixtures of hardwoods and softwoods may be even more productive than the Swedish softwood forests. It is perhaps not without significance that the portion of the United States with drivable streams has been subject to cutting for the longest period of any region and yet is still in a productive condition.

One is impressed with the completeness with which the country is covered with forest, particularly in north Sweden. Here one sees practically nothing but forest, with occasional lakes and streams and here and there a small farm; and all the forest is under management. It is on a much vaster scale than in central Europe, where one goes through farming country and occasional forests. The forest industries are also organized on a large scale; one sees many huge sawmills and large pulp mills. The lakes which we saw, in contrast with similar wooded lakes in the United States which would be dotted with summer camps, were without sign of human habitation. This does not mean that outdoor recreation is not highly developed in Sweden, but that the opportunities around Stockholm and the more thickly settled parts of the country are so abundant, with the innumerable islands and bays on the Baltic and large inland lakes, that it is unnecessary to use the smaller lakes in the north.

A good deal of attention was devoted to plots illustrating various methods of thinning. The principal system is from below, but we were shown some parts in which the French method of thinning from above had been tried successfully. In even-aged stands of tolerant species, the French method, while requiring more skill, seems to produce better results in that the trees have better crowns and can put on more rapid growth. Thinnings in Scotch pine, particularly on private lands, are as a rule heavy, and the stands are left rather open. The open stands, in spite of the smaller number of stems, have shown just as great a

volume of growth as the less open ones and of course a higher value increment since the growth is put on larger stems. In contrast with open forests in the United States, which would grow up with brush or inferior species, the forest floor has only a cover of moss or low shrubs such as *Vaccinium vitis idaea*, *Calluna vulgaris*, *Vaccinium myrtillus*, and various herbs and low shrubs depending on the quality of the site.

In north Sweden we saw thinnings made from an entirely different point of view from any which we had before considered in that connection, namely to increase the soil temperature. The spruce stands on the uplands here are very dense and grow slowly. The thinnings, by allowing the warmth to reach the soil, advance the period at which growth begins in the spring, reduce the thickness of the frost in the ground, and markedly increase the increment. These thinnings also increase the depth of snow covering by permitting more to reach the ground.

Although site qualities are based on height, yet the indicator value of the under-vegetation is clearly recognized and widely used. Malmström, in his account of the vegetation of the Kulbäcksliden and Svartberget forests, bases his description on the plants of the forest floor, making three broad classes: (1) Lichen-rich, (2) *Hylocomium*-rich, and (3) *Polytrichum commune*-rich and *Sphagnum*-rich. Under these he recognizes subdivisions, the most productive being the *Dryopteris* type, of which we saw an excellent example. We were fortunate in having with us Dr. Yrjö Ilvessalo, who was extremely helpful in enabling us to correlate the site qualities with the forest types used by Cajander in Finland. Anyone interested in this problem in America should read Ilvessalo's account of his application of Cajander's type system to some of our forests, particularly in the west [1]

During the two weeks' excursions we had ample opportunity to observe soil conditions and their influence on growth. We saw the work of Dr. Hesselman and his colleagues which is too well known to repeat. One aspect of his investigations which has not been as yet published upon, and which was particularly interesting, concerned his trenching experiments. These were made in a pine heath, that is, an open stand of Scotch pine with an under story of predominantly heather, where the reproduction developed very poorly. The trenching experiments were negative, as also were experiments in which distilled water was added, showing that root competition was not a factor. On the other hand, the addition of small quantities of nitrogen gave an immediate response, indicating that the difficulty here is the poverty of the soil, particularly the lack of nitrogen.

In north Sweden the imperviousness of the soil in some places gives rise to the development of water-logging and semi-bog conditions even on slopes. The forest here is predominantly spruce. We had the privilege of seeing on the Oxböle State Forest near Bispgården a forest of spruce in which this problem was well illustrated. The forest, predominantly spruce with a small scattering of pine, had been very little disturbed and was just being placed under management. The problem was whether to

[1] Ilvessalo, Yrjö. Notes on some forest (site) types in North America. Acta forestalia fennica, Vol. 34: 1-111.

use the selection or group selection system which would readily secure reproduction, or to clear cut, burn off the humus, and plant with Scotch pine. The latter had been the accepted method in the past; some delegates favored it and others favored the selection system. The question is merely which will give the highest returns and has not as yet been decided.

If justification were needed for the wise policy adopted by the U. S. Forest Service in reserving sample areas of virgin forest as examples of the working of undisturbed natural forces, it is found in Sweden. We were shown in the south a very old forest of oak and beech which, while probably not absolutely primeval, had been relatively little disturbed and was extremely interesting. They have also set aside forests in central and northern Sweden, those in the north approaching most closely virgin conditions.

At the meetings in Stockholm the papers were distributed into a number of sections according to subjects, in addition to several general papers. These papers will eventually be available in published form. The Executive Committee after, we understand, a good deal of discussion, presented proposals for the organization of the Congress. The essential feature is that each country has one official delegate and one vote, rather than having the representation by individual experiment stations. The scope of the Union was broadened to include all forms of forest research and to permit organizations not maintained by the state to become participating members. Single members are now admitted under certain restrictions.

It was decided to hold the next meeting of the Union in France in 1932, and Philibert Guinier, Director of the Experiment Station at Nancy, was elected as the next President, with Gyula Roth, Sopron, Hungary, as Vice-President. The Permanent Committee is composed of these officers and of Wladislaw Jedlinski, Warsaw, Poland; Ludwig Fabricius, München, Germany; R. C. Robinson, London, England; Aldo Pavari, Florence, Italy; and Henri Badoux, Zürich, Switzerland. Sven Petrini of the Swedish Forest Experiment Station was appointed Secretary.

Not only was the Congress most efficiently organized and handled, but the hospitality extended was extremely generous and cordial. The large forest owners and companies did not merely write out checks, as so many of our big business men do, but threw open their houses and entertained us most lavishly. The banquet by the city of Stockholm, in the superb setting of their justly famous new Hotel de Ville, expressed in regal fashion the interest in forestry and hospitality of the Swedish people. A feature of all the entertainments which was particularly appreciated by the Americans was the absence of long speeches, a few words by not more than half a dozen delegates being deemed sufficient.

Barrington Moore.

Notes on European Forestry

The following observations are based on studies made by the writer during the course of a trip to Europe in the spring of 1928:

1. Light sandy loam formerly under cultivation has long since been converted into timberland.

In northeastern Germany a vast area of this type of land, nearly all of which was once used for the usual agricultural crops, has been planted to timber because its owners could not compete successfully with those owning better land. It was found impossible to secure fertilizers in sufficient quantities to keep all of the soil productive. At present a high percentage of the land is planted with trees for timber production, mostly in large forest tracts, but woodlots of all sizes which occupy the poorest spots on the farms are very numerous.

2. Seeds from forest trees frequently transmit the characteristics of their parents to a marked degree.

Approximately 20 years ago test plots in series were established at several forest experiment stations in Germany with seeds of Scotch pine and Norway spruce from different sections of Germany and from various other European countries. Great variations in the growth and form of the trees occurred. The plots in which seeds from local sources were planted showed uniformly excellent, vigorous trees; others showed fair to good trees; and still others trees lacking in vigor or of poor form. While no conclusions can be drawn from these experiments as to the inherent characters in successive generations, they do show that careful selection of seed is an important factor in planting where success or failure depends upon the first generation.

3. Serious mistakes were made in planting over large areas in using pine transplants or seeds the parents of which were not adapted to the region.

In the light-soil region of Germany are thousands of acres of decidedly inferior stands of Scotch pine. Such stands in many cases occur side by side with stands which are good or excellent. There are 60-year-old Scotch pine stands in which the trees remaining after cutting out the worthless ones are only large enough to make fair-sized fence posts and so short that only two posts on the average are secured from the better trees, while many are useful only as fuel. Other woodlots contain a high percentage of crooked trees after the poorer trees have been cut out. The general opinion of scientists skilled in forestry is that the poor stands are the results of using seeds from unknown sources, or from stunted trees, the cones of which were easily gathered because they grew comparatively close to the ground.

It is especially noteworthy that Scotch pine trees from parents not adapted to the locality produce cones at an early age. Generally speaking, when foresters observe a tract of pine in which the trees produce cones at an early age, good timber is no longer expected, and in many cases such tracts are completely cleared and replanted with seeds from recognized strains. Laws and mutual agreements among seed dealers now assure the sale in a locality of only such seeds as are suitable for the region. This practice appears to have resulted in promising stands of young pine in a high percentage of recent plantings. Foresters are of the opinion that good seeds for one region may be decidedly poor seeds for another region, and that seeds from poorly formed trees are not worth planting in any region. Cones must not be collected before the seeds are fully mature, because immature seeds frequently show a lack of vigor or a low percentage of germination.

4. Important external factors which influence the development of forest trees are climate, elevation, and soil.

Of the external factors which determine whether a variety of tree is suitable for a given locality, climate seems the most important. A tree which starts growth too early in the season as a seedling or a transplant will continue to start growth too early for that locality, and similarly a tree which matures its new wood late when young will continue to do so when the tree is old. The general opinion of experimenters is that a tree will not adopt itself to the climatic conditions to any great degree throughout its life.

Elevation is considered another important factor, and atmospheric pressure may have some effect, but no data as to the latter have been secured. The type of soil is regarded as less important, provided the rainfall is sufficient. Lime in the soil is required for beech, and most hardwoods cannot be produced at a profit on light sandy loam.

5. There is a strong tendency to grow timber in mixed instead of pure stands.

This tendency is based upon the contention that some species withstand the force of wind better than those which are the most important from the standpoint of timber production, chiefly Scotch pine (*Pinus silvestris*) on light, sandy soil and Norway spruce (*Picea abies*) in the highlands of southern Germany. Furthermore, the needles from the former do not furnish much soil covering; while the latter produces a thick duff which in places is so acid that seedlings, although produced in large numbers, cannot develop root systems sufficient to penetrate into the mineral soil and therefore die before they are three years old. Indications are that the needles of larch in the duff have a neutralizing effect, and larch is therefore desirable in a stand of spruce. Chemical effects of hardwood leaves in the duff have not as yet received thorough scientific consideration but on account of their physical effects elm, oak, linden, and beech are desirable in mixtures where they are adapted with respect to soil and altitude.

6. The growing of foreign trees for timber production has not been much of a success.

Although a great number of imported species have been planted experimentally in Germany, it is of special interest to note that only one, Douglas fir, grown from seeds from a limited area in America, seems to have the qualities which will in the future warrant its propagation on a large scale. A few other species, American and Asiatic, have limited uses, but in extensive tracts they cannot be considered as promising a profit on the investment. Even the number of native timber species which yield a profit is very limited. Of the total timber area in Germany, as given by Prof. Dr. Max Wolff in Der Deutsche Wald, one-half is Scotch pine, one-fifth Norway spruce, less than one-sixth beech mixed with other hardwood, one-twelfth oak, one-fortieth fir, and one-eleventh other species. Elm, larch, white birch, and poplar are often found in mixtures with the more important species. In the highlands of southern Germany, Norway spruce is the dominant species; but beech, white oak, and larch occur in large numbers at certain altitudes.

In conclusion emphasis should be laid on the fundamental importance of good seed in reforestation. Unselected seed is a gamble with small chance to win, and

the practice of mixing seed from widely scattered localities and different types of soil is basically unsound. Seeds should be collected only from trees with superior qualities, even though the cost is high, and careful records should be kept as to source of every lot of seed up to the final plantation.

The planting of large tracts to foreign species, or to native species not adapted to the locality, should be avoided. In any locality suitable for forest purposes every effort should be made to preserve good stands of the species native to that locality, and to reforest with seeds from the best trees of the species. If several species which possess high-grade timber qualities prevail, a mixture seems preferable to a pure stand. In all cases where extensive reforestation is attempted, expert advice from men who are thoroughly acquainted with the region should be secured; other advice is usually worthless, and sometimes causes great damage. Under comparable economic conditions, planting a woodlot is as sound a proposition as planting any other agricultural crop; the failures, excepting in case of fire, are usually due to poor management at some point from the selection of the seed to the harvest. Efforts used in taking care of growing timber will, in time, yield as good a return as efforts used in taking care of any other crop.

H. J. Ninman.

Forestry in Soviet Russia

Russia today seems a land of contradictions. Innumerable conflicting reports covering every possible subject reach us; so with this in mind the writer journeyed as far east as Moscow in April, 1929, to learn as much as possible of what is being accomplished in forestry under the Soviet regime.

The fact that the timber resources of this vast country are approximately one-third of the world's store constitutes impressive evidence of the importance of forests in the U. S. S. R. (United Socialist Soviet Republics). From a commercial view, it is estimated that some 50,000,000 board feet of spruce with some pine will be shipped from Russia and marketed in the eastern United States this year. Within a few months pulpwood shipments will begin to one of our large paper-manufacturing companies. Though only in a small way, yet we are already dependent on Russian forest products. What of Russian forestry?

A brief summary of forest history in Russia may help to give more background to the present work and aspirations. Peter the Great was the first ruler to limit the cutting of forests in certain districts. In 1703 he forbade the cutting of oaks and pines at a distance of 35 miles from the principal rivers, and in 1719 the cutting of oaks anywhere. Previous to this time, in 1696, it is stated that Peter himself took part in the first reforestation work near the city of Taganrog in southern Russia.

In 1766 the first book on forestry in Russia was published—a translation from the German of Fokel, a Teutonic authority who had been invited to come to Russia. At this time, certain forestry work was accomplished.

During 1785, under Catherine II, the first forest laws were made effective, and 13 years later a state forestry depart-

ment was organized. In 1800 the first class in forestry was formed at the Navy School. This developed in three years so that a forestry school was opened, which was moved to Leningrad in 1829, and this year (1929) marks the centenary of its existence on the same site in the old Russian capital.

In 1839 the corps of Forest Inspectors was organized, but it was not until 1869 that hired forest inspectors were employed. Previously the peasants were obliged to serve as watchmen in the state forests. On January 1, 1915, 31,780 men were employed in state forests, and 11,518 state-built houses were used by forest inspectors.

The growth of the national mind towards forestry resulted in 1832 in the organization of a society for the promotion of forest economy. From this time on many forest publications have been issued.

The basic laws for the Soviet Republics were issued on May 27, 1928. These nationalized all forest property and declared the lumber trade a government monopoly.

Before the Revolution more than 50 per cent of the forests were state owned. In 1913 the state-owned forests showed a gross income of $42,916,667 with expenditures amounting to $12,617,500. In 1927-28 the income from forests was $125,351,000. Only 18 per cent of the state-owned forests in European Russia were worked prior to the World War and a negligible 1 per cent in Siberia.

In 1921 the People's Commissariat for Agriculture planned to bring about better utilization by repairing railways over an area of 9500 miles; by building 867 miles of new lines; by improving water transportation over 1100 miles; and by draining an area of 54,000 acres. They also took measures to protect the forests more generally from fire; to reforest considerable areas including protective belts for the crops in drought regions by planting an area of 4185 acres; and to keep a record of felled timber. Reforestation work in which it is hoped the peasants will participate has also been recently inaugurated.

These plans have gone forward year after year until it is planned by October 1, 1929, to have completed (1) forest organization on 158,250,000 acres; (2) a forest economic investigation of 198,500,000 acres; (3) the improvement of some 2600 miles of rafting routes; (4) the forestation of vast areas of shifting sands; and (5) drainage work on large sections of burnt and cut-over areas which have not regrown.

The direct supervision of forestry matters is under seven chief inspectors of forests throughout the Soviet Republics who are accountable in turn to the Communist Government at Moscow.

In 1928 the total amount expended in forestry work was $25,315,855, and in 1929 it is estimated that $31,930,000 will be spent as follows:

	Per cent
Forest organization and economic investigation	46.4
Reforestation	19.6
Melioration	10.7
Roads	5.3
Forestation of moving sands	5.2
Technical and civil construction	8.5
Experimental work	3.3
Hunting economy	1.0
Total	100.0

In reforestation work the following amounts have been expended during the past three fiscal years from October 1 to September 30:

1925-1926	$515,000
1926-1927	638,085
1927-1928	1,310,160

In the Black Forest of Germany the transportation and climatic conditions are ideal for the practice of intensive forestry; in Russia quite the contrary is true with the heavy snows and long winters, especially in the great wooded sections of the northeast which contain one-sixth of the merchantable timber in all the Soviet Republics. The principal species in this region, which includes Archangel, Komi, Vologda, and North Dvinsk, include approximately 40 per cent *Pinus sylvestris,* 25 per cent *Larix sibrica,* and 35 per cent *Picea obovata* and *P. abies.* Here also are birch and *Populus tremula,* but these have no marketable value because of transportation difficulties and are given no consideration in the cutting. Only the best specimens are removed down to a D.B.H. of 28 cm. In these isolated spots natural regeneration is usually obtained seven to eight years after this selective system of cutting has been applied. At present only 5.5 per cent of the annual new growth is being cut.

In the central section, the Moscow industrial region, comprising Tver, Yaroslav, Ivano-Voznesensk, Kostroma, Kaluga, Moscow, Vladimir, and Nizhni-Novgorod, there is also birch and poplar as well as *Quercus pedunculata* and *Ulmus glabra,* but the two important timber trees in approximately even quantity throughout the region are *Pinus sylvestris* and *Picea obovata.* Here, with better transportation and more seasonable weather conditions, the forests are clear cut in strips some 150 feet wide, with wider strips to be used beginning this year. The rotation for the pine is 100 to 120 years and for the spruce 100 years; where the spruce is cut for pulpwood, a rotation of 80 years is used. Natural regeneration is obtained in from five to forty years.

Weeding of the birch is resorted to when it is very small, and the work therefore inexpensive, in order to give the pine and spruce in mixed stands more light. No figures are available as to how much has been spent in this work. The average wage per month, however, for forest labor is $32.45.

In 1927 some 7500 acres were planted with one and two-year Scotch pine seedlings. This planting represented about 75 per cent of the area covered, while the remaining 25 per cent was seeded with spruce.

In the south, or Caucasus region, are some hundred valuable species including Circassian walnut, beech, oak, hornbeam, ash, maple, birch, elm, chestnut, and some conifers. Even here intensive forestry is not being practiced although a selective system is in vogue in these mixed forests. The area of these forests is estimated at 18,600,000 acres.

In the Far East the forests cover an area of some 313,000,000 acres, but are at present neglected with enormous quantities of timber being destroyed each year by fires or disease. In Siberia and the Far East only 2.5 per cent of the total annual growth is being harvested each season.

Forestry is not intensive in Russia as yet, but after talking with many Soviet leaders and observing the work actually

completed, one cannot help catching the spirit of "will-to-accomplish" existent in the new Russia. In no economic work does it seem to find greater expression than in forestry.

T. F. LUTHER.

A UNIQUE LOOKOUT STATION

A unique fire lookout station was completed in April, 1929, on the Quinaielt Indian Reservation, and is now in use. A Douglas fir tree well over 200 feet in height, and better than 6 feet in diameter on the stump, standing on a high knoll overlooking the entire northeastern portion of the reservation, was "topped" by high climbers about 176 feet from the ground, and a house 7 feet square was built on the tree at a point about 170 feet from the ground.

The building of this fire lookout station, which was done by a coöperative agreement between the Hobi Timber Company, one of the largest logging operators in western Washington, and the Forestry Branch of the United States Indian Service, presented peculiar difficulties. After the tree was "topped," four railroad ties, crossed set in notches, were securely bolted to the tree. A 2 x 8 inch plank, 7 feet long, was bolted to the ties on all four sides of the tree, and on this foundation the house was built. The floor is a little more than 170 feet from the ground. About 4½ feet of the top of the tree trunk was left sticking up through the floor of the house, making a very convenient base for the fire finder.

The house, which is 7 feet square and 7 feet high at the eaves, was framed on the ground, and a whole side hauled up to its desired location by means of a hand winch and tackle. Openings 6 x 3 feet were left in each side, and window frames with three sliding windows were made to fit each opening. The roof was shingled with red cedar shingles, and cedar siding was used on the sides of the house.

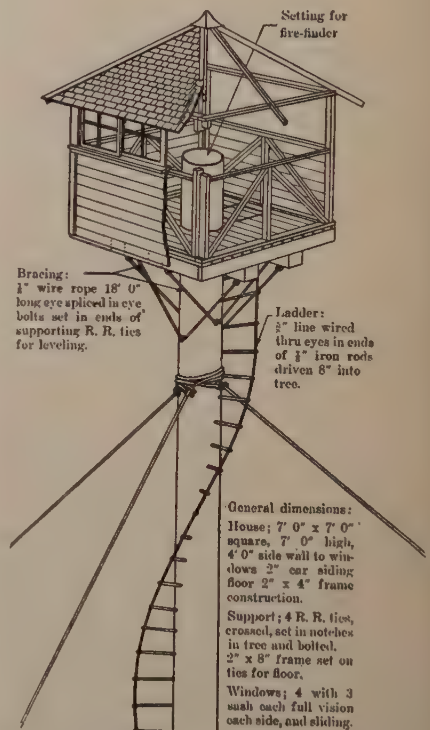

FIG. 1.—Plan for tree lookout tower, Quinaielt Indian Reservation, Washington.

The house is reached by means of a rod and rope ladder, and entered by a trap door in the floor. The ladder was built in the following manner: Inch steel rods, about 3 feet long with a hole in the end, were driven about 8 inches into the tree about 16 inches apart in such a manner that they made a winding staircase. The ends of these rods were threaded by a steel cable which was securely fastened to the top of the tree

and tightened at the bottom of the tree by a chain block. As this steel cable was tightened the ladder was made very taut because of the fact that the ladder winds around the tree and the pressure made by tightening the cable would tend to hold the ladder up tight against the tree.

The tree is securely guyed by three wire-rope cables which are fastened to the tree just below the house and tightened by chain blocks around near-by stumps.

The lookout house is connected by a telephone to the headquarters camp of the Hobi Timber Company, and because this station also overlooks a portion of the Olympic National Forest another telephone line has been built connecting with the district ranger of the United States Forest Service at Lake Quinault. A lookout man, who is an employee of the forestry branch of the United States Indian Service, is stationed in the tree during the fire season, and has been furnished with an Osborne fire finder, properly oriented, high power binoculars, maps of the surrounding country, etc.

The tree station has demonstrated its practicability so thoroughly during the past fire season, that we have taken steps to make it a permanent station. We have barked the tree and will paint it with creosote next summer; have thoroughly oiled the guy lines with fuel oil (this was done during hot, dry weather this summer); have painted the ladder and cables with rust-proof iron paint; and have painted the observer's house, roof and all. We have also erected a cabin for the observer at the foot of the tree, and as a finishing touch erected a 14-foot flag pole on the roof of the house. The top of the flag pole is approximately 190 feet from the ground.

Henry B. Steer.

Utah Expands Forestry Program

The State of Utah, through the Extension Service of the State Agricultural College at Logan, has entered into a coöperative agreement with the federal government under the provisions of Section 4 of the Clarke-McNary Act. Charles M. Genaux, formerly assistant in forestry at the State College of Washington, has been appointed as Extension Forester for the state and also as Assistant Professor at the Utah State Agricultural College.

Work is already under way for the establishment of a nursery in the vicinity of the Agricultural College for the production of woodlot, windbreak, and shelterbelt planting stock for coöperative distribution to farmers. While the new nursery is being developed, it is expected that considerable planting stock will be distributed by the Extensive Service through the courtesy of the School of Forestry at the University of Idaho.

A large field for tree planting exists in the State of Utah. Early settlers established windbreaks in nearly all the communities in which they lived. However, these plantations have reached maturity and windbreaks and small woodlots planted 50 or 60 years ago are now decadent and should be replaced. With the knowledge now at hand, it will be possible to replace many plantations with longer lived and more valuable species than those which were originally planted. In eastern Utah, where agricultural development has taken place only in recent years, an opportunity is at hand to plant longer-lived and more valuable species at the start, and to so place windbreaks and woodlots that they will furnish the greatest possible protection to the community at large.

The Utah nursery will be developed and cared for by the Extension Service. Student labor will be employed as much as possible and the nursery will be used as a field laboratory for students in the Department of Forestry at the State Agricultural College.

The possibility of a highway planting program is also being investigated in the belief that judicious planting may reduce the cost of winter road maintenance. Extensive highway planting would eliminate many of the bleak snow fences which are now so often necessary.

Forestry 4-H club work will be started at an early date through the help of D. P. Murray, state club leader. Considerable interest in forestry has already been evinced by boys' and girls' clubs and by boy scouts.

Forestry in the Florida Legislature

The last session of the Florida State Legislature adjourned without making any changes in existing general forestry laws. No forestry measures had been sponsored by the Florida Board of Forestry, and of the three measures introduced by others none was passed.

An annual appropriation of $61,000 was granted to the Florida Board of Forestry, an increase of $48,500 over that for the preceding year. This appropriation, supplemented by funds from the Federal Forest Service and private property owners, will allow the Florida Board of Forestry a budget of over $150,000. Of this amount $129,000 will be expended for educational and forest fire control work. With the increased funds available it will be possible to expand the protected area by more than 1,000,000 acres, and to provide at least 10 protective units in addition to the seven already in existence.

Sixteen thousand dollars will be devoted to educational work. This will include coöperation with the American Forestry Association in its Southern Educational Project of showing motion pictures in every rural community in Florida. In addition, it will provide for fair exhibits, leaflets and pamphlets, posters, lectures, and educational work in the schools. This work will be under the direction of Assistant State Forester H. A. Smith.

Five thousand dollars will be devoted to coöperation with property owners in the raising and distribution of forest tree seedlings, in the establishment of forest tree plantations, demonstration plots, and improvement cuttings, and in applied forestry in general. This work will be under the direction of Forest Assistant C. H. Coulter.

Forestry in the Los Angeles Schools [1]

Since April 26, 1927, the Los Angeles city schools have been using a 250-acre tract on the Clear Creek branch of the Big Tujunga for reforestation purposes under a special use permit from the U. S. Forest Service. Several buildings have been constructed, mainly from scrap lumber and other salvaged materials, by the caretakers, school teachers,

[1] Taken from the annual report of the Forestry Bureau of the Vocational and Elementary Agriculture Divisions, Los Angeles City Schools, by Assistant Directors William R. Tanner and Francis M. Fultz.

school boys, and other helpers. With the aid of the Forest Service four miles of trail, one mile of road, and four miles of telephone line have been made, brush lands and fire lanes have been cleared, and 2400 square feet of seed beds have been constructed and fenced.

During the past school year 1528 pupils and 143 adults visited the Clear Creek project, making a grand total of 4808 visitors since its establishment. The pupils during the past year came from 22 elementary, 13 junior high, and 16 high schools; the visitors came from six states, the Philippine Islands, England, Russia, and Switzerland.

Some 1500 pounds of seed of native trees and shrubs were collected, mainly by groups of boys from the summer playgrounds, by groups of junior and senior high pupils, and by pupils from some of the outlying elementary schools. Seed of other species not readily available from Clear Creek was obtained by exchange with the County Forestry Department. The nursery at Clear Creek now contains about 18,000 nurslings, 3900 one-year-old trees, and 2675 one-year-old trees in tar-paper pots, chiefly of Coulter pine, knobcone pine, and incense cedar.

Propagation of native trees and shrubs has been carried on to a varying extent at 15 high schools, 9 junior high schools, 75 elementary schools, and 6 agriculture centers. Approximately 10,000 plants have been raised at these various gardens, nearly all of which will be used in school-ground planting in conjunction with the Landscape Division of the city schools. Plans are under way for the coming season for a material extension of this work, whereby native trees and shrubs will be used in large numbers at certain of the schools where there is unused ground especially suited for this sort of landscaping.

The forestry classes at the San Fernando high school have been carried on with gratifying success. The class which was started in September, 1926, has finished the third year and is ready for the final year's work, which in the forestry line will be in botany. Interest in the work among the boys taking this course is sustained and commendatory.

Douglas Fir Plywood Manufacturers Turn to Research

During the past two years the demand for Douglas fir plywood has so far exceeded the expectations of the manufacturers that new and more scientific methods of production are constantly being sought in an effort to satisfy the steadily increasing demand. Plywood manufacturers have long known that the time consumed in assembling the several plies of veneer, the spreading of the glue, the moisture content and temperature of the stock used, the amount of pressure used in pressing the various veneers together, and other factors, have all influenced the quality of their finished product, but just how far and whether or not there were other counteracting agents have been more or less unknown.

To meet this situation the manufacturers have concluded that exhaustive research work must of necessity be carried on. Arrangements have therefore been made with Messrs. I. F. Laucks, Inc., chemists and manufacturers of Lauxein Waterproof Glues, Seattle, Washington, to inaugurate a systematic inspecting and testing service, the re-

sult of which it is hoped will be a continued improvement in the quality of Douglas fir plywood.

The various manufacturing operations will be constantly checked and samples periodically secured for strictest examinations and testing. Compilations of data will be secured from a large number of different manufacturing plants, and a comprehensive study of these data on the part of the manufacturer will enable him to improve on his present methods, should improvement be necessary. Those manufacturers who avail themselves of this service should be able to furnish users of Douglas fir plywood with more complete and accurate data concerning its properties and to use the correct methods of manufacture for each particular need.

Isaac W. Bernheim Foundation

Isaac W. Bernheim, former Louisville, Kentucky, capitalist and philanthropist, and now a resident of Denver, Colorado, has established a reserve of 13,100 acres of rugged timber land in Bullitt and Nelson Counties, Kentucky, for the purpose of returning the land to its primitive state by reforestation and silvicultural management, and affording a permanent bird and animal sanctuary. The forest will be managed by the Isaac W. Bernheim Foundation, created and endowed by Mr. Bernheim.

During the past year a thorough examination of the tract has been made by John Lafon, who has outlined plans for its intensive management. Fire protection and improvement activities have already been started by Ronald B. Craig, who is the local officer in charge of the forest.

It is Mr. Bernheim's hope that the forest will aid in demonstrating the possibility of constructive forest practice in Kentucky and in developing a favorable public opinion which will give increased moral and financial support to state forestry activities. It will be at least a year before the public is admitted to the tract, but it is hoped that when the road and trail system is in proper shape, it will be extensively used by the public in the same manner and for the same purposes as state and national forests and parks.

Howard W. Siggins
1893-1929

Howard W. Siggins, associate silviculturist in the California Forest Experiment Station and senior member of the Society of American Foresters, died early September 3 as a result of injuries sustained the night before near Sonora in the Stanislaus National Forest, when his car left the road, overturned, and crushed him beneath.

Howard Siggins was a man of the greatest promise and was expected to go far in forest research work. Personally he was a man of quiet ways, and was devoted to his work. He endeared himself to all with whom he came in contact. As an investigator he was painstaking and careful, and was particularly capable in carrying on his work independently. In his death forestry has lost a very useful man, and those who knew him will miss a friendly and inspiring comrade.

Siggins was born in Meadville, Pa., on July 10, 1893, and graduated from the Mont Alto Forest Academy at Mont Alto, Pennsylvania, in 1914. There

followed three years of service with the Pennsylvania State Forest Service; then a year and a half with the 20th Engineers in France. At the close of the war he came to California to engage in ranching with his father. Finding the call of forestry still too strong to resist, he came to the University of California, enrolled as a graduate student, and received the M. S. degree in May, 1926. He passed the Civil Service examination for junior forester with the highest percentage. Since his graduation he was with the California Forest Experiment Station, and was engaged upon several important silvicultural investigations. He was a member of Sigma Xi, Phi Sigma, and Xi Pi honor societies, and was a winner of the Pack Forestry Prize in 1926 and 1927.

He is survived by his wife, Margaret Smith Siggins, his father and mother, a brother, and a sister.

EMANUEL FRITZ.

SOCIETY AFFAIRS

Making "Sabbaticians" Useful[1]

I offer the following suggestion regarding that hardy perennial—a secretary for the Society:

The Council should at an appropriate date and annually thereafter invite applications for the post of Secretary from forest school professors eligible for sabbatical leave, and fill the place accordingly for the period of one year. The advantages are:

1. The faculties of the forest schools will offer a wide field of choice, and men can be obtained to serve during their leave of a calibre impossible to obtain for permanent employment.

2. The one year of service means sustained enthusiasm, fresh viewpoint, and ideas. The menace of developing a "professional" secretary will be wholly avoided.

3. Professors on sabbatical leave receive pay in whole or in part; a supplementary salary of $4000 or $5000 for services as Secretary would seem fair and attractive, and would offset costs incident to the maintenance of temporary residence in Washington. No permanent secretary of value to the Society could be obtained for such a salary. There would be a distinct saving and a liberal and necessary travel allowance would be possible.

4. The benefit will be three-fold: to the Society, to the forest schools, and to the sabbaticians or whatever you call professors when they are turned loose for a year.

Arthur Ringland.

[1] From a letter of September 2, 1929, to Paul G. Redington, President, Society of American Foresters.

Allegheny Section Holds Summer Field Meeting

The seventh annual summer field meeting of the Allegheny Section was held July 25-27, 1929, with the State Forestry Departments of Delaware and Maryland as the joint hosts. Thirty-nine members of the Section and 17 guests, of whom seven were members of the Washington Section, were present.

The meeting was unofficially opened with a smoker held Wednesday evening, July 24, at the Hotel duPont Biltmore in Wilmington.

Thursday morning at 9.00 a. m. the caravan of 20 cars left Wilmington, arriving a short time later at the famous gardens of the duPont family at Longwood, where sufficient time was allotted for an inspection of the beautifully landscaped grounds. The party were guests of Mr. Willard Springer, a member of the Delaware Forestry Commission, at luncheon served at his Rockland estate.

Following the luncheon the party left in excellent spirits for the Wilmington Marine Terminal where they were shown through the mill of the Tannin

Corporation where tannin is extracted from quebracho logs. A visit was also made, between showers, to the lumber yards where millions of feet of West Coast lumber are handled annually.

The next stop was at Middletown, where one of the earliest and most successful plantations in the state was visited. Planted by the Pennsylvania Railroad in 1910 on exceptionally poor soil, the trees have made remarkable growth and served as an excellent object lesson of the possibilities of red oak and loblolly pine in Delaware.

After returning to Middletown, State Forester Taber of Delaware, who had acted as guide and host up to this point, turned the party over to the guidance of State Forester Besley of Maryland, who escorted the party to Elkton, where accommodations were provided for the night.

The annual summer dinner and business meeting were held that evening in the Hotel Howard with Chairman W. M. Baker presiding. After informal reports by the Secretary-Treasurer and several committees the Chairman called on State Foresters Taber, Besley, Wilber, and Newins, as well as Mr. H. R. Condon, all of whom responded with short talks.

Friday morning before leaving Elkton the party visited the Jessup-Moore paper mill where high grade book and magazine paper is made from southern pine wood. A short distance from Elkton a stop was made at the plant of the Victory Sparkler Company where commercial fireworks are manufactured. Demonstrations were given with smoke bombs, signal torches, torpedoes, and rockets.

The next stop was made to show a railroad safety strip constructed by the Pennsylvania Railroad according to the Maryland law which has proved very effective in eliminating a very serious fire hazard.

At Principio a visit was made to the Whitacker Iron Company where the furnace which dates back to 1715 was viewed. The adjacent tract of 7000 acres has been in continuous forest management for over two centuries in the production of charcoal used in the manufacture of the iron. Cannon used in the defense of Fort McHenry were cast at this furnace.

Lunch was served at the U. S. Veterans Hospital at Perryville, where the party was entertained and shown over the grounds by the hospital staff. Improvement cuttings on the Reservation and basket-willow plantings were among the objects of interest.

Continuing across the Susquehanna River to Aberdeen a roadside planting of cypress along the entrance of the U. S. Proving Grounds was visited. After leaving Aberdeen the party visited a recent cutting by Mr. S. D. Peverly of 3000 acres, located at Stepney. This operation is being conducted along approved forestry lines with an aim toward sustained yield.

On the outskirts of Bel Air, the stopping place for the night, a visit was made to one of the few water-powered up and down sawmills still in operation in America. This mill has been in continuous operation by the Fowble family for over 50 years and is of unknown age. Its treadmill return makes it one of the most unique sawmills in the country.

Dinner that evening was served at the Country Club Inn at Bel Air and was followed by several informal talks by many of the foresters present.

The first stop Saturday morning was at the Morse sawmill in Cooptown. This mill is unique as it has been in continuous operation by the Morse family for nearly 90 years and is now operated by the grandsons of the original owner. A short visit was also made to the adjoining woodland which has been operated on a sustained yield basis during the entire life of the sawmill.

At 11.00 o'clock the party arrived at the famous Conowingo Dam, one of the largest hydroelectric developments in this section of the United States, which was constructed in 1926-1927.

Following the inspection of the entire project the party broke up at noon with nothing but praise for the Delaware and Maryland Committee which consisted of State Forester F. W. Besley, Chairman, with State Forester Taber and Assistant State Forester Fatzinger of Delaware, and Assistant State Foresters Pfeiffer and Curry of Maryland as members.

H. F. Round,
Secretary-Treasurer.

Changes in Membership

The following men have been elected to the grade of membership indicated, effective September 1, 1929:

Allegheny Section

Junior Membership

Brady, Norris D.
Jones, Theodore R.
MacDonald, James C.
Ritt, William G.
Shaner, W. A. J.

Appalachian Section

Junior Membership

Dean, George W.
Wilson, Thomas A.
Wood, Arthur A.

Associate Membership

Tilghman, H. L.

Central Rocky Mountain Section

Junior Membership

Beals, Wilfred F.
Chapman, Roy A.
Horton, Gerald
Hill, Ralph R.
Pike, Galen W.

Senior Membership

Anderson, S. Duval
Donery, Joseph A.
Janouch, Karl L.
Peteram, H. D.
Schrader, W. H.

Gulf States Section

Junior Membership

Moore, Robert
Righter, F. L.
Smith, Elton J.

Minnesota Section

Junior Membership

Clement, Raymond
Goldberg, Hyman
Lindstrom, Gustof

Nelson, Alfred L.
Orr, Leslie W.
Van Alstine, J. N.

Senior Membership

Barker, William L.
Hopkins, Howard
Stott, Calvin

NEW ENGLAND SECTION

Junior Membership

Daley, Raymond K.
Faull, Joseph H.
Hills, F. G.
Ingall, O. D.
Isola, Vico C.
Koomey, Levan H.
Locke, John P.
Melcher, Edmund C.
Phipps, Carl L.
Turner, George W. C.
Wing, Gerald E.

Senior Membership

Buttrick, Philip L.
Friend, Francis H.
Goodwin, James L.
MacAloney, Harvey J.
Reed, Paul M.
Stickel, Paul W.

NEW YORK SECTION

Junior Membership

Erickson, Eugene T.
Keur, Johan Y.
Rudolf, Paul.

Associate Membership

Luther, Thomas C.

NORTH PACIFIC SECTION

Junior Membership

Baker, William J.
Cochran, Allan R.
Cummings, Laurence H.
Howarth, James A.
Lund, Walter H.
Schreiner, Fred J.
Weaver, Harold

NORTHERN ROCKY MOUNTAIN SECTION

Junior Membership

Centerwall, Willard R.

Senior Membership

Johnson, Eric A.

OHIO VALLEY SECTION

Junior Membership

Dalke, Paul D.
McGraw, Edward B.
Martin, Glenn C.
Morey, Cedric F.
Tappenden, Richard

Senior Membership

DeCamp, John C.
Kellogg, Leonard F.
Leffelman, L. J.
Westveld, R. H.

WISCONSIN SECTION

Senior Membership

DeFlon, Leland
Weber, Wallace W.

NO SECTION

Junior Membership

Connell, Alison B.
Commins, Maurice J.

The following men have been elected to the grade of membership indicated, effective October 1, 1929:

ALLEGHENY SECTION

Junior Membership

Aughanbaugh, J. E.
Berg, Birger
Butz, George W., Jr.
Thatcher, Donald M.
Tyler, John

APPALACHIAN SECTION

Junior Membership

Henneberger, F. C.

Senior Membership

Broadbent, Sam R.
Buell, Jesse H.
Claridge, Frederick

Associate Membership

Tyler, W. D.

CALIFORNIA SECTION

Junior Membership

Hurt, Bert
Jones, William V.

GULF STATES SECTION

Junior Membership

Dunlop, William R.
Prater, P. F. Wallace

Senior Membership

Wakeley, Philip C.

INTERMOUNTAIN SECTION

Junior Membership

Davis, Robert

MINNESOTA SECTION

Junior Membership

Scholz, Harold

NEW ENGLAND SECTION

Junior Membership

Davis, Arthur A.
Kreager, Paul T.

NEW YORK SECTION

Associate Membership

Houghton, Augustus S.

NORTHERN ROCKY MOUNTAIN SECTION

Junior Membership

Burroughs, Isaac C.
Derrick, Walter J.
Dwinelle, Justin K.
Emerson, J. L.
Gilbert, C. W. Earle
Joy, Edward L.
Knutson, C. E.
Lukens, Stanley M.
Matthews, F. S.

Senior Membership

Anderson, I. V.
Billings, Roger W.
Brooks, James F.
Brown, A. A
DeJarnette, George M.
Evenden, James C.
Faunce, C. D.

Haig, I. T.
Haines, Roscoe
Jefferson, Frank J.
Lowell, John W.
Myrick, E. H.
Phillips, R. A.
Ryan, James E.
Shoemaker, Theodore
Smith, Glenn A.
Taylor, Thomas
Wyckoff, Stephen N.

NORTH PACIFIC SECTION

Junior Membership

Ewing, Carl M.
Huntington, LeRoy W.
Rawie, Carl D.

NO SECTION

Junior Membership

Cooper, Sidney N.

The following have been dropped from membership in the Society because of non-payment of dues for 1928:

Junior Membership

Conrad, Howard H.
Durbin, Martin H.
Eger, B. A.
Haines, Paul B.
Lee, J. G.
McCallister, James C.
Merrill, M. C.
Mink, O. W.
Norris, Thomas G.
Robb, W. A.
Strickland, S.
Tarbox, Errol E.
Van Orsdel J. P.
Vessey, James K., Jr.

Senior Membership

Gutches, G. A.
Lockwood, Milton K.

Announcement of Candidates for Membership

The following names of candidates for membership are referred to Junior Members, Senior Members, and Fellows for comment or protest. The list includes all nominations received since the publication of the list in the May Journal, without question as to eligibility; the names have not been passed upon by the Council. Important information regarding the qualifications of any candidate, which will enable the Council to take final action with a knowledge of essential facts, should be submitted to the undersigned before December 15, 1929. Statements on different men should be submitted on different sheets. Communications relating to candidates are considered by the Council as strictly confidential.

FOR ELECTION TO GRADE OF JUNIOR MEMBER

Name and Education	*Title and Address*	*Proposed by*
Baird, John C. Univ. of Idaho, B. S. F., 1927	District Forest Ranger, Pidera District, San Juan N. F., Pagosa Springs, Colo.	Central Rocky Mt. Sec.

Name and Education	*Title and Address*	*Proposed by*
Chappel, S. F. High school graduate; three years Forest Service correspondence courses	Forest Ranger, Crystal River District, Holy Cross N. F., Carbondale, Colo.	Central Rocky Mt. Sec.
Clarke, Ray R. Two years high school; number of Forest Service study courses	Assistant Supervisor, Gunnison N. F., Gunnison, Colo.	Central Rocky Mt. Sec.
Dickson, Bly Two years business college; correspondence courses in surveying, drafting, elementary forestry, range management, botany, English	District Ranger, Tongue District, Bighorn N. F., Dayton, Wyo.	Central Rocky Mt. Sec.
Gould, H. A. One year high school; correspondence courses Forest Service	Forest Ranger, Harney N. F., Custer, S. Dak.	Central Rocky Mt. Sec.
Goulden, James J. Penn. State B. S. F., 1928	District Forester, W. Va. Fish and Forestry Commission, Montgomery, W. Va.	Allegheny Sec.
Hauser, Harry D. High school education	Forest Ranger, Miguel District, Uncompahgre N. F., Nucla, Colo.	Central Rocky Mt. Sec.
Henry, Edward H. Four years N. Y. State College of Forestry, lacking one hour for one year (drafting)	Assistant Forest Ranger, Fox Park District, Medicine Bow, N. F., Fox Park, Wyo.	Central Rocky Mt. Sec.
Henry, Leslie G. Univ. of Minn., B. S. F., 1926	Forest Ranger, Dubois, Wyo.	Central Rocky Mt. Sec.
Hurley, Owen B. Mich. State College, B. S. F., 1928	Forest Ranger, Bears Ears District, Routt National Forest, Craig, Colo.	Central Rocky Mt. Sec.
Kirkham, Dayton P. Univ. of Minn., B. S. F., 1928	Junior Forest Ranger, Colorado N. F., Allens Park, Colo.	Central Rocky Mt. Sec.
Kirkmire, D. F. Graduate, N. Y. State College of Forestry, June, 1927	Forest Ranger, Keystone District, Medicine Bow N. F., Holmes, Wyo.	Central Rocky Mt. Sec.
Krausz, Harry B. (Reinstatement) Four years Baltimore City College, 1904; one year Univ. of Va.; one and one-third years Yale School of Forestry, 1913	Manager, Dimension Lbr. Plant, Pearl River Valley Lumber Co., Canton, Miss.	Gulf States Sec.
Krueger, Carl G. Univ. of Minn., B. S. F., 1927	Junior Forest Ranger, Washakie N. F., Lander, Wyo.	Central Rocky Mt. Sec.
Lang, George P. High school; commercial school; six Forest Service correspondence courses	Senior Forest Ranger, Gore District, Routt N. F., Steamboat Springs, Colo.	Central Rocky Mt. Sec.

Name and Education	*Title and Address*	*Proposed by*
Leadbeater, John C. N. Y. State, B. S. F., 1927	District Ranger, San Luis Dist., San Isabel N. F., Crestone, Colo.	Central Rocky Mt. Sec.
Limstrom, Gustaf A. Univ. of Minn., B. S. F., 1928	District Ranger, Sioux River Dist., Crane Lake, Minn.	Central Rocky Mt. Sec.
Massey, I. M. High school; business colleges; one year forestry Univ. of Idaho	District Ranger, Hill City Dist., Harney N. F., Hill City, S. Dak.	Central Rocky Mt. Sec.
McKinley, Raymond M. Iowa State, B. S. F., 1928	District Forest Ranger, Harney N. F., Keystone, S. Dak.	Central Rocky Mt. Sec.
Nolen, Earl High School	Forest Ranger, Tomichi District, Cochetopa N. F., Sargents, Colo.	Central Rocky Mt. Sec.
Pletcher, William H. Univ. of Mich., B. S. F., 1928	Forest Ranger, Washakie N. F., Lander, Wyo.	Central Rocky Mt. Sec.
Poley, William F. Colo. Agric. College, B. S. F., 1928	Forest Ranger, Pole Mtn. Dist., Medicine Bow N. F., Laramie, Wyo.	Central Rocky Mt. Sec.
Rotty, Roland Iowa State, B. S. F., 1920	District Ranger, Nebraska N. F., Halsey, Nebr.	Central Rocky Mt. Sec.
Schaal, Donald George Mich. State, B. S. F., 1927	District Ranger, Goose District, Bighorn N. F., Centennial, Wyo.	Central Rocky Mt. Sec.
Schipull, Walter L. Iowa State, B. S. F., 1927	Forest Ranger, White River N. F., Burro Mt. Dist., Buford, Colo.	Central Rocky Mt. Sec.
Shaw, Donald W. Univ. of Mont., B. S. F., 1927	Forest Ranger, Leadville N. F., Leadville, Colo.	Central Rocky Mt. Sec.
Shirley, Hardy L. Indiana Univ., B. A., 1922; Yale, Ph. D. in Forestry, 1928	Associate Silviculturist, Lake States For. Exp. Sta., St. Paul, Minn.	Minnesota Sec.
Spillers, Arthur R. N. Y. State, B. S. F.	Junior Forester, Southern Forest Experiment Station, New Orleans, La.	Gulf States Sec.
Thomson, Rich R. High school	Forest Ranger, Glenwood Ranger District, Glenwood Springs, Colo.	Central Rocky Mt. Sec.
Truman, Roy M. Common school	Forest Ranger, Westcliffe District, San Isabel N.F., Westcliffe, Colo.	Central Rocky Mt. Sec.
Varney, Gilbert L. Univ. of N. H., B. S. F., 1927; N. Y. State, M. F., 1928	In charge of Colorado Spruce Co. timber sale, Montezuma N. F., Rico, Colo.	Central Rocky Mt. Sec.
Wheelis, Willis B. La. State, M. S.; Yale. M. F., 1928	Junior Appraiser. U. S. F. S., Athens, Tenn.	Appalachain Sec.
Whitehill, Benjamin M. Univ. of Minn., B. S. F., 1928	Forest Ranger, South Platte Dist., Buffalo, Colo.	Central Rocky Mt. Sec.
Young, Donald Conn. Agric. B. S.; Yale, M. F., 1929	Junior Forester, U. S. F. S., Franklin, N. C.	Appalachain Sec.

FOR ELECTION TO GRADE OF SENIOR MEMBER

Name and Education	*Title and Address*	*Proposed by*
Burrage, Clarence Hill Univ. of Ga., B. S. F., 1915; Georgia Col. of Forestry, 1915-16 (Junior Member 1923)	In charge of 15,000-acre forest being brought under intensive management, Univ. of Ky.	Appalachain Sec.
Leighou, John V. Penn. State, B. S. F., (Junior Member 1921)	Forest Supervisor, Arapaho N. F., Hot Sulphur Springs, Colo.	Central Rocky Mt. Sec.
Smith, Eastburn R. Amherst, A. B., 1920; Yale, M. F., 1922 (Junior Member 1924)	District Ranger (Senior Grade), Winslow, Ariz.	Southwestern Sec.
Stadtmiller, Louis R. Yale, Ph. B., 1910; M. F., 1911 (Junior Member 1923)	Director of Forests & Fisheries, Haitian Government Service, Port-au-Prince, Haiti	Samuel J. Record R. C. Hawley H. H. Chapman A. F. Fischer Geo. P. Ahern
Woodhead, Phillip V. High school; night school in business college (Junior Member 1923)	Forest Supervisor, Routt N. F., Steamboat Springs, Colo.	Central Rocky Mt. Sec.

B. A. CHANDLER,
Member of Council in Charge of Admissions.

SOCIETY OFFICERS

Officers and Members of Executive Council

President, Paul G. Redington, Biological Survey, Washington, D. C.
Vice-President, J. F. Preston, Hammermill Paper Co., Erie, Pa.
Secretary, R. E. Marsh, Forest Service, Washington, D. C.
Treasurer, W. N. Sparhawk, Forest Service, Washington, D. C.

Executive Council

The Executive Council consists of the above officers and the following members:

	Term expires		Term expires
R. Y. Stuart	Dec. 31, 1932	J. S. Holmes	Dec. 31, 1933
Aldo Leopold	Dec. 31, 1931	W. G. Howard	Dec. 31, 1933
T. T. Munger	Dec. 31, 1930	Ovid M. Butler	Dec. 31, 1929

Member in Charge of Admissions

B. A. Chandler..............Dec. 31, 1929

Section Officers

Allegheny

W. M. Baker, Chairman, Department of Conservation and Development, Trenton, N. J.
T. W. Skuce, Vice-Chairman, University of West Virginia, Morgantown, W. Va.
H. F. Round, Secretary, Forester's Office, Pa. R. R. Co., Philadelphia, Pa.

Appalachian

M. A. Mattoon, Chairman, U. S. Forest Service, Asheville, N. C.
E. H. Frothingham, Vice-Chairman, Appalachian Forest Experiment Station, Asheville, N. C.
John W. McNair, Secretary, U. S. Forest Service, Asheville, North Carolina.

California

E. I. Kotok, Chairman, 305 Hilgard Hall, Berkeley, Calif.
Woodbridge Metcalf, Vice-Chairman, 305 Hilgard Hall, Berkeley, Calif.
M. E. Krueger, Secretary, 305 Hilgard Hall, Berkeley, Calif.

Central Rocky Mountain

Allen S. Peck, Chairman, Forest Service, Denver, Colo.
John W. Spencer, Vice-Chairman, Forest Service, Denver, Colo.
J. A. Donery, Secretary, Forest Service, Denver, Colo.

Gulf States

G. D. Marckworth, Vice-Chairman, Louisiana State University, Baton Rouge, La.
N. D. Canterbury, Secretary, New Court House, New Orleans, La.

Intermountain

C. N. Woods, Chairman, Forest Service, Ogden, Utah.
R. J. Becraft, Vice-Chairman, Utah Agricultural College, Logan, Utah.
E. W. Nelson, Secretary, Forest Service, Ogden, Utah.

Minnesota

C. G. Bates, Chairman, University Farm, St. Paul, Minn.
R. M. Brown, Secretary, University Farm, St. Paul, Minn.

New England

E. C. Hirst, Chairman, 11 Tahanto St., Concord, N. H.
A. C. Cline, Secretary, Harvard Forest, Petersham, Mass.

New York

Samuel N. Spring, Chairman, Cornell University, Ithaca, N. Y.
J. Nelson Spaeth, Secretary, Cornell University, Ithaca, N. Y.

Northern Rocky Mountain

C. D. Simpson, Chairman, U. S. Forest Service, Missoula, Mont.
M. I. Bradner, Secretary, U. S. Forest Service, Missoula, Mont.

North Pacific

Geo. W. Peavy, Chairman, Oregon State Agricultural College, Corvalıis, Ore.
William F. Ramsdell, Member of Executive Committee, Box 4137, Portland, Ore.
E. J. Hanzlik, Secretary, Box 4137, Portland, Ore.

Ohio Valley

C. J. Telford, Chairman, 504 N. Romine St., Urbana, Ill.
R. B. Miller, Secretary, Department of Conservation, Springfield, Ill.
B. E. Leete, Chairman of Membership Committee, Room 51, First National Bank Bldg., Portsmouth, Ohio.

Southeastern

I. F. Eldredge, Chairman, Fargo, Ga.
Harry Lee Baker, Vice-Chairman, Tallahassee, Fla.
W. M. Oettmeier, Secretary, Fargo, Ga.

Southwestern

Hugh G. Calkins, Vice-Chairman, U. S. Forest Service, Albuquerque, N. M.
Quincy Randles, Secretary, Forest Service, Albuquerque, New Mexico.

Washington

Barrington Moore, Chairman, 1520 K St., N. W., Washington, D. C.
E. Morgan Pryse, Secretary, Office of Indian Affairs, Washington, D. C.
R. E. Marsh, Member of Executive Committee, Forest Service, Washington, D. C.

Wisconsin

R. D. Garver, Chairman, Forest Products Laboratory, Madison, Wis.
John B. Cuno, Secretary, Forest Products Laboratory, Madison, Wis.